Digitized by the Internet Archive
in 2010 with funding from
University of Toronto

http://www.archive.org/details/memoirs40harv

MEMOIRS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT

HARVARD COLLEGE.

VOL. XL.

154066
20/1/20

CAMBRIDGE, U.S.A.
PRINTED FOR THE MUSEUM.
1910–1915.

QL
1
H35
V.40

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XL. No. 1.

SOLENODON PARADOXUS.

BY

GLOVER M. ALLEN.

With Nine Plates.

CAMBRIDGE, U. S. A.:
Printed for the Museum.
June, 1910.

CONTENTS.

No. 1.— SOLENODON PARADOXUS. By Glover M. Allen. 9 plates. June, 1910 . . 1

No. 2.— BREWSTER'S WARBLER. By Walter Faxon. 1 plate. January, 1911 . . 55

No. 3.— THE CHISMOPNEA (CHIMAEROIDS). By Samuel Garman. September, 1911 . 79

No. 4.— SOME CHINESE VERTEBRATES.

INTRODUCTION. By Samuel Henshaw 107
PISCES. By Samuel Garman 111
AMPHIBIA AND REPTILIA. By Thomas Barbour 125
AVES. By John E. Thayer and Outram Bangs 137
MAMMALIA. By Glover M. Allen 201
6 plates. August, 1912.

No. 5.— ZAGLOSSUS. By Glover M. Allen. 2 plates. October, 1912 249

No. 6.— BREWSTER'S WARBLER (HELMINTHOPHILA LEUCOBRONCHIALIS) A HYBRID BETWEEN THE GOLDEN-WINGED WARBLER (HELMINTHOPHILA CHRYSOPTERA) AND THE BLUE-WINGED WARBLER (HELMINTHOPHILA PINUS). By Walter Faxon. August, 1913 309

No. 7.— A NEW MYLODON. By Glover M. Allen. 4 plates. September, 1913 . . 317

No. 8.— NOTES ON THE CRAYFISHES IN THE UNITED STATES NATIONAL MUSEUM AND THE MUSEUM OF COMPARATIVE ZOÖLOGY WITH DESCRIPTIONS OF NEW SPECIES AND SUBSPECIES TO WHICH IS APPENDED A CATALOGUE OF THE KNOWN SPECIES AND SUBSPECIES. By Walter Faxon. 13 plates. July, 1914 347

No. 9.— STUDIES FROM THE NEWPORT MARINE LABORATORY.— XVI. THE DEVELOPMENT OF OSSEOUS FISHES. II. THE PRE-EMBRYONIC STAGES OF DEVELOPMENT. PART SECOND. THE HISTORY OF THE EGG: CLEAVAGE, FORMATION OF THE PERIBLAST, AND DEVELOPMENT OF THE GERM RING. By Alexander Agassiz and C. O. Whitman. 11 plates. April, 1915 429

CONTENTS.

	Page
INTRODUCTION	5
HISTORY	5
HABITS	7
EXTERNAL APPEARANCE	8
Color	10
External measurements	12
Cranial measurements	14
SUPERFICIAL BODY MUSCLES	14
MUSCLES OF HEAD AND NECK	15
MUSCLES OF THE TRUNK	19
MUSCLES OF THE FORE LIMB	21
MUSCLES OF THE HIND LIMB	25
MUSCLES OF THE TAIL	32
OSTEOLOGY	33
VISCERAL ANATOMY	43
Digestive system	43
Glands	46
Mesenteries	47
Lungs	48
Heart and its vessels	48
Excretory and genital organs	48
BRAIN	49
PLEXUSES	50
SUMMARY	51
LITERATURE	54
EXPLANATION OF PLATES	

SOLENODON PARADOXUS.

INTRODUCTION.

The Museum has recently been fortunate in securing from San Domingo, a series of specimens of the rare *Solenodon paradoxus* Brandt. Four of these were brought alive, and were successfully photographed by Mr. George Nelson. The more interesting of the photographs were reproduced with the Annual Report of the Curator for 1907–08. The present paper is a comparative account of the general anatomy of the species, made possible by this fresh material. For the loan of its specimens of *Solenodon cubanus* thanks are due the United States National Museum.

HISTORY.

The brief history of this species is now well known. It was originally described in 1833 by J. F. Brandt from a skin and an imperfect skull, in the St. Petersburg Academy, from Haiti. This specimen was subsequently studied by Peters in connection with the Cuban species, described by him in 1864. Leche states that he too, made use of this skull and other fragments of the skeleton, when in 1907 he published his extensive paper on the teeth of the Insectivora. The exact nature of the other fragments is not stated but from the text it appears that a pelvis with the sacral vertebrae labeled as of this species, was among the material studied. These bones were figured by Leche who called attention to the remarkable characters shown by them in comparison with those of other Insectivora. There can be no doubt, as will be shown later, that the pelvic and sacral bones figured are not those of Solenodon. Through the labors of Peters and Dobson, the anatomy of *Solenodon cubanus* was fairly well known more than twenty years ago, but no additional specimens of *S.*

paradoxus were discovered until 1907, when A. Hyatt Verrill secured an adult male, an adult female, and a young individual still retaining its milk dentition. Of these specimens, Dr. J. A. Allen (:08) has given a brief account. The skulls and dentition are well figured by him and critical comparison is made with skulls of *S. cubanus*. The preservation of the skin and soft parts of the specimens was too poor to admit of further detailed study, however. A brief paper by Verrill (:07) recounts the few facts he was able to glean as to the habits of these animals in San Domingo. The present account will, it is hoped, serve partially to fill the hiatus existing in our knowledge of the general anatomy of the species.

Specimens of the Cuban Solenodon, were made known by Poey in 1834, through a communication to a Havana paper, "El plantel." Later, in 1851, he gave a more detailed notice of the animal, with a colored plate, in his "Memorias sobre la historia natural de la isla de Cuba." Poey obtained specimens from the mountainous regions east of Bayamo, Cuba, where the animal was said to be well known. This author reviews at some length the early accounts of the native Cuban animals, and after an exhaustive search, fails to find any evidence that it was known to the early historians of the country. Since he was unable to attach to it any of the native names of animals mentioned by these writers, he proposed to call it the Almiqui, a name derived from that of one of the mountains in the eastern department of Cuba near where his specimens were taken. He supposed the Cuban animal to be conspecific with that of Haiti and San Domingo. Gundlach subsequently obtained examples from the Sierra Maestra, but Ramon de la Sagra's statement that it occurs in the region of Trinidad, Cuba, Poey takes pains to show, is based solely on the latter's note in "El plantel" concerning vague reports of an animal in that region whose identity could not be certainly established.

According to A. H. Verrill (:07, p. 56), the natives of San Domingo have various names for *Solenodon paradoxus*, as Orso (bear), Hormigero (ant-eater), Juron (ferret) "also applied to the mongoose," and Milqui. In his list of the mammals of Middle America and the West Indies Elliot gives it a vernacular name "Agouta," whose origin I have been unable to discover.

HABITS.

Of the habits of this species in a wild state very little is definitely known. According to Verrill's (:07) account it is "nocturnal, and spends the day in caves, holes in the coral limestone rocks and in hollow trees and logs." At night it leaves its retreat and comes forth to feed, "rooting in the earth and cultivated grounds, tearing rotten logs and trees to pieces with its powerful front claws, and feeding on ants, grubs, insects, vegetables, reptiles, and fruit, and at times proving destructive to poultry. On several occasions it has been known to enter the houses in search of roaches and other vermin, and has been captured in rat-traps." Mr. Verrill's wash drawing shows the animal with tail bent around at the side of the body, and the mounted specimen in the American Museum of Natural History is prepared in a similar manner. Such a posture for the tail is, however, probably never assumed, as its stiffness admits of but slight lateral flexure, and the muscle masses actuating its movements are almost wholly dorsal and ventral. In the living animals the tail is held straight out behind, somewhat depressed, but slightly elevated at the tip to permit it to clear the ground. The tip alone seems capable of slight lateral movement. The tail serves very effectively as a support when the animal is eating. It then throws itself back, with the soles of the hind feet resting their full length on the ground, and the powerful tail acting as a third leg of a tripod. In this position one or both of the fore feet can be lifted from the ground.

In feeding, the animals walk clumsily about with a stiff waddling gait, sniffing here and there at the objects that come in their path. The toes only are in contact with the ground as they walk, while the metatarsals are quite clear. They eat greedily of chopped meat, and will take lettuce as well by way of variety. Meat they give considerable mastication, opening the jaws widely as they chew. That they are capable of very quick movements, in spite of their apparent clumsiness, is seen when two or three are eating together and disagree as to the possession of some morsel of food. If one attempts to rob another, like a flash the possessor of the dainty throws its body around away from the pursuer and continues chewing greedily. Often one will seize its companion by the snout, and if wickedly inclined can bite severely. Usually, however, they seem peaceful enough. Rarely a shrill cry is uttered, as Mr. George Nelson tells me, who has heard it while tending the captive specimens. At other times, they constantly give an explosive sniff as if clearing the nose. They are mainly active at night or in the late afternoon, and seem to dig over

and under every movable article in the cage. They have a pronounced odor, not disagreeable, and reminding one slightly of that of a goat or a porcupine, yet characteristically different.

Verrill states that a female in his possession gave birth to three young, which, however, she promptly devoured. One of the females in the lot belonging to the Museum likewise brought forth her young in captivity, but in this case but a single one was found. If others were born, they too must have been devoured. This young one when probably a day or so old had the eyes and ears still closed. The hair was beginning to appear, although not sufficiently to clothe the body. It was a female (Plate 1, fig. 1) and had the single pair of mammae well developed. It lived but three days, at the end of which time the first upper and the two first lower incisors were erupted, but the eyes and the ears were as yet unopened.

EXTERNAL APPEARANCE.

In general form Solenodon is shrew-like, with a long tapering snout, elongate head and a stout tail. The feet and limbs are not notably modified, though the fore claws are greatly developed. The great development of the snout beyond the nasal bones is a striking peculiarity, shared, however, to some extent by the African genera Macroscelides and Rhynchocyon. This proboscis in *Solenodon paradoxus* is cartilaginous, and consists of a long tube, quadrangular in section (Plate 5, fig. 2) and deeper than wide. The nasal septum divides the cavity of the proboscis and is continued into the nasal chamber; a projecting ridge on each side of the septum, partly divides the lumen of the proboscis into a dorsal and a ventral tube. At its proximal end the proboscis is ventrally supported by a small round bone, the os proboscidis, and laterally it is held in place by a short triangular cartilage on each side from the upper free edges of the premaxillaries. These cartilages are loosely bound to the sides of the proboscis by connective tissue. The tip of the snout has a naked rhinarium about a centimeter in length ventrally whose posterior border is ill defined dorsally just posterior to the nostrils, but below it is sharply marked off from the surrounding haired surfaces by a slight groove. A median groove runs from the upper incisors to the tip of the snout which here is slightly emarginate. The nostrils open laterally and are somewhat crescentiform. The sides of the snout are supplied with about a dozen large vibrissae, the longest of which measure about 65 mm. There are in addition shorter hairs from swollen bases, that are coarser

than those surrounding and are doubtless tactile. A single vibrissa 25 mm. long is present on the midline of the chin below the angle of the mouth. Two or three long coarse hairs are also found midway between the eye and the ear.

The ear is large, and nearly round in general outline, though the anterior margin is straight. A large posterior basal lobe is marked off by a conspicuous notch halfway on the posterior border. A smaller lobe is similarly indicated at the base of this larger lobe. The whole appears to be comparable with the antitragus of other mammals. On its internal surface is a rounded ridge. This and the more ectal portion of the antitragus are thinly covered by hair. The tragus, at the base of the antero-internal border of the ear, is a barely indicated marginal prominence. A prominent metatragus is well developed, just below and anterior to the center of the ear. It consists of a large rounded lobe anteriorly with a short small ridge-like projection just posterior and parallel to it. These two prominences are placed slightly obliquely to the vertical axis, inclined forward. From the notch separating postero-dorsally the antitragal lobe, a prominent ridge is developed, with a somewhat crescentiform outline, the concavity ventral, projecting inward nearly a third the diameter of the ear. There is on each ear, directly above this ridge and about 3 mm. from the posterior rim of the conch, a low round papilla. The border of the ear is slightly emarginate above this papilla, a result possibly of injury, since the two notches are not of exactly the same appearance in the two ears. The distal half of both inner and outer surfaces of the conch is sprinkled with minute appressed hairs. The ear of *S. cubanus* is slightly larger.

The body is round and stout, the limbs heavy and muscular. The latter present no remarkable modifications, but the claws of the anterior digits are greatly developed, apparently for scratching the surface rather than for burrowing in the earth. In the Cuban Solenodon they are absolutely longer and more slender, although the animal itself is smaller. The three middle digits of fore and hind feet are subequal. The innermost digit is in each case the shortest. The hind foot is of a very generalized type, and with long metatarsal bones suited to the semi-plantigrade method of walking.

The tail is long and stout in *S. paradoxus*, though rather more slender, relatively, than in *S. cubanus*. In both it is covered at the base by dense hairs, fine and very short, which extend forward to the posterior part of the rump, where the long hairs abruptly stop. The tail is covered with very small scales, between which are scattered minute hairs. Near the base of the tail there are about 36 scales in a single transverse row.

The mammae are two in number in both species, inguinal, or even post-inguinal, situated far apart, on a line just anterior to the genital opening. The number and position of the mammae are thus remarkably different from those in Centetes with its twelve pairs extending from the axillae to the groins. Potamogale, however, has but a single inguinal pair.

The general body hair is long and coarse dorsally, becoming finer and slightly crinkled on the sides and venter. On the back two sorts of hairs are distinguishable: (1) the abundant shorter and finer hairs, and scattered among these, (2) single coarse hairs. The latter appear to have larger follicles and these, in a skin of *S. cubanus* that has lost some of the hair, are seen to be arranged in oblique rows, at intervals in the dried skin of about 5 mm. In a young *Solenodon paradoxus* three days old (Plate 1, fig. 1), these coarse hairs are well developed, averaging some 5 mm. in length, and scattered at close intervals in similar oblique rows. With a hand lens the more abundant finer hairs may be seen at the bases of these larger ones. They are very minute and seem to be at least three between each two of the large bristles in a transverse row, while others are scattered between the rows. It seems not unlikely that the coarse spiny hairs present mainly in a longitudinal row on each side in the young of Centetes are homologous with these bristles in Solenodon. The further echinate development of the corresponding hairs in Centetes is seen in the adult that has scattered spine-like hairs over the dorsal area mingled with the more abundant finer hairs of the general body surface. The further development of a spiny dorsal covering such as is present in Erinaceus, would seem to be thus foreshadowed in these two genera. The statement of Verrill (:07) that the legs, snout, and tail are naked, and that the rump is bare, is not strictly correct. The rhinarium is quite hairless, as are also the soles of the feet, but the rest of the snout, legs, and rump are covered with minute hair, and small appressed hairs spring from between the scales of the tail.

Color.— In the series of skins at hand there is great variation in the extent and intensity of the colors, and this appears to be independent of sex. The commonest type (Plate 3) has the dorsal surface of the head from the base of the snout to the ears and nape, black. The basal half of the hairs is pale buff. About the eye the long hairs are reflexed in a sort of rosette, and their pale bases thus form an encircling light-colored area. The black-tipped hairs extend over the mid-dorsal area of the back to the rump and are everywhere intermingled with pale, nearly buff-colored hairs, that give thus a grizzled effect to the dorsum. Ventro-laterally from the median line, the black hairs decrease in number, while

the buff hairs become more numerous, so that on the sides of the body and on the forearm they produce a clear buff or cream buff. This color of the sides extends ventrally from the abdominal region to the upper part of the chest where it passes into a deep ferruginous, almost chestnut, over the ventral surface of the throat, upper chest, bases of the fore limbs and dorsally to the sides of the neck. The inguinal region also is ferruginous. The short hairs of the feet and distal portion of the snout are of the same buffy color as the venter, with a slight admixture of ferruginous hairs around the mouth. A whitish nuchal spot, about 15 by 10 mm. in extent, is present in all but one of the specimens, and seems to be a characteristic of the species. The presence of a white nuchal spot is due to the failure to meet of the two lateral pigment areas whose centers are on the sides of the neck, as has been elsewhere indicated by the writer. The condition of partial albinism thus produced has here become fairly permanent, so as to result in a definite pattern. A similar restriction of the dermal pigment of the tail has taken place, so that a varying length, usually nearly the distal half, is white.

Variations from the type of coloration above described occur through an increase or a decrease in the intensity of the pigment. One female shows a maximum of increase in the black of the dorsum. This color is deep on the head and extends to the elbows on each side, while on the back the admixture of buffy hairs is very slight until well down on the sides of the body the clear buff area is reached. The white nuchal spot exists in this specimen as a few scattered hairs, hardly noticeable. Ventrally the lower surface of the forearm and the inguinal region from tibia to tibia is suffused with ferruginous.

The opposite extreme is shown by another female in which the black is so dilute, not only on the dorsal area as a whole, but in the separate hairs, that it appears as a distinct brownish, nearly drab of Ridgway's Nomenclature of colors, grizzled with buff hairs. The latter become slightly tinged with rufous on the sides and venter.

The ferruginous tint (Plate 2) is exceptionally well developed in two large and apparently old females and in a third smaller animal, an adult male. In the brighter of the two old females the buffy hairs of the back and sides of the head and body and on all but the mid-ventral region are replaced by ferruginous, even the nuchal spot being of this tint. The ventral portion of the chest and the lower throat where the ferruginous is brightest in other specimens, have in this example become so intensified that they are nearly black. The third bright specimen above mentioned is the most brilliant. The dark throat area is nearly

maroon shading into deep ferruginous on the sides of the neck, while posteriorly the sides of the body and the venter are orange-rufous, somewhat more ferruginous on the lower surface of the arms and on the inguinal region. The nuchal spot in this specimen is bright buff.

A very young female (Plate 1, fig. 2) is much paler in color than any of the adults. The dorsal area has a general tone of brocolli brown due in part to the dilute pigmentation of the black hairs and the paleness of the buffy hairs, which are here of a light cream buff. This color also extends over the sides and mid-ventral region becoming more intense a buff on the inguinal region and on the lower throat and chest. The ferruginous tints of the adult are quite absent at this early age.

The long vibrissae are usually buffy or ferruginous, but sometimes black.

Between the various styles of coloration just described all gradations occur. The black of the dorsum may be so restricted as to cover but a narrow median area or it may extend almost to the ventral border of the body. Again it may be so intermixed with buffy hairs that instead of showing clear black it appears as a uniformly grizzled drab, with all intermediate gradations of coloring. The color of the underparts in the youngest specimens varies from a uniform buff to ochraceous-buff and ochraceous, but in the adults the buff is often confined to the sides and abdomen and shades into ochraceous on the inguinal region and into ferruginous on the chest and throat. Others, however, have the inguinal area buff like the sides and abdomen. Again, the ferruginous of the throat may extend ventrally upon the abdomen, reaching an extreme in the case of an old female that has the entire belly and sides suffused with this color. Some have the abdominal surface nearly clear drab. All the specimens show the white nuchal patch except one or two highly colored adults in which this area is suffused with the buff or the ferruginous of the sides and belly. The white spot varies from a narrow streak 6 mm. wide and 12 mm. long to a blotch about 20 by 25 mm.

The great difference in color between *S. paradoxus* and *S. cubanus* has been pointed out by Dr. J. A. Allen. In the Cuban species the pelage is finer and longer. The dorsum is more uniformly dark without the admixture of lighter hairs. The uniform dark color of the back continues on to the feet, the thighs, forearms and chest while the greater part of the head and part of the mid-ventral area are pale yellowish, or in alcoholic specimens nearly white.

External measurements.— The following measurements are of ten adults, a young male, and a second younger animal, a female, but three days old, born in

captivity. All but the last were alcoholic specimens. The last was measured shortly after its death. Measurements are in millimeters.

Sex.	Total length	Eye to tip of nose.	Eye to ear.	Height of ear from meatus.	Breadth of ear.	Incisors to tip of nose.	Length of rhinarium.	Chin to corner of mouth.	Manus with longest claw.	Pes with claw.	Olecranon to tip of longest claw.	Tail from anus.	Length of white tail tip.
♂	520	67	34	29	24	31	9.5	25	52	68	106	222	70
♂	561	71	31	31	26	35	10.5	32	57	70	111	254	—
♂	525	64	27	30	22	35	11.0	33	59	69	108	241	130
♂	526	69	35	29	24	38	11.5	29	55	68	110	240	128
♂	530	69	35	31	25	39	10.0	30	53	67	110	222	141
♂[1]	365	58	24	26	22	32	11.0	25	49	64	88	154	77
♀	551	71	32	27	22	39	11.0	29	51	67	104	238	80
♀	528	65	30	28	22	35	9.0	26	51	68	104	242	121
♀	531	68	32	29	25	35	10.0	30	54	70	109	238	94
♀	545	72	36	29	24	40	10.0	35	51	68	107	240	138
♀	543	69	26	29	23	37	11.0	29	53	68	108	240	99
♀[2]	195	33	15	9.3	8	18	5.5	14	25	33	47	72.5	—

This table shows that adults of both sexes are essentially alike in size, and present a comparatively small amount of variation in the measurements. As additional data for comparison the following measurements of two males and two females are given following the order in Dr. J. A. Allen's (:08, p. 512) paper:

	♂	♂	♀	♀
Length of head (in straight line)	120	127	119	127
Breadth of head in front of ears	44	51	44	52
Length of eyelids (fissure)	5	5	5.5	4
Distance of eyes from each other	28	30	27	33
Breadth of proboscis at base	18	17	20	17.5
Height of proboscis at middle	11	11	10	9
Height of proboscis at base	18	16	17	16
Distance between corners of mouth	30	26	26	35
Thickness of tail at middle	10	10	10	11
Length of hand to end of 3d digit (without claws)	34	41	37	42
" " 1st digit (without claw)	9.5	9.5	10.5	9.5
" " claw of 1st digit (over curvature)	8	11	10	10
" " 2d digit (without claw)	14	15	14.5	16
" " claw of 2d digit (over curvature)	18	21	19	17
" " 3d digit (without claw)	17	16	17	16
" " claw of 3d digit (over curvature)	18	21	19	17
" " 4th digit (without claw)	16	17	14	17
" " claw of 4th digit (over curvature)	17.5	20	18	17
" " 5th digit (without claw)	12	12	11	14
" " claw of 5th digit (over curvature)	11	11.5	10.5	11
Length of foot to end of middle digit (without claw)	59	59	60	64
" " 1st digit (without claw)	10	9.5	9	9
" " claw of 1st digit (over curvature)	7	8	7	8
" " 2d digit (without claw)	13	14.5	14	16.5

[1] Immature.
[2] Three days old.

	♂	♂	♀	♀
Length of claw of 2d digit (over curvature)	10.5	12	10	10
" " 3d digit (without claw)	14	16	13	14
" " claw of 3d digit (over curvature)	10.5	12	10	10
" " 4th digit (without claw)	14	16	12	14
" " claw of 4th digit (over curvature)	10.5	12	10.5	10
" " 5th digit (without claw)	13.5	13	11	14
" " claw of 5th digit (over curvature)	8.5	10	9	9.5

Cranial measurements.— An adult skull exhibits the following measurements: greatest length, 87; greatest median length, 82.8; basal length, 77; palatal length, 37; interorbital constriction, 15.8; breadth outside first incisors, 10.5; breadth outside second premolars, 17; greatest width between outer molar margins, 24; greatest prezygomatic breadth, 34.7; greatest postzygomatic breadth, 34; mastoid breadth, 27; occipital breadth, 19.7; maxillary toothrow (including incisors), 40; length of mandible, 58; greatest height at coronoid process, 26; length of mandibular toothrow, 35.5; width of condyle, 9; length of mandibular symphysis, 19.

SUPERFICIAL BODY MUSCLES.

The *sterno-facialis* is a thin sheet of muscular fibers arising from fasciae along the anterior part of the pectoralis. The fibers from opposite sides are somewhat interlaced on the throat. This sheet extends forward over the prominent thyroid glands to the mandibular symphysis and dorsally on to the sides of the face, becoming inserted by thin tendinous fibers into the skin of this region.

The *panniculus carnosus* is extraordinarily developed and thickened over the dorsal region, where it forms a tough, mainly tendinous sheet about 2 mm. thick. This sheet is attached to the tips of the dorsal spines by thin strands of muscle and tendon and to the vertebral edge of each scapula and the posterior third of the scapular crest. A few slight strands of tissue connect it with the ecto- and ento-pectorales ventrally, and its main insertion, after dipping beneath the ecto-pectoralis, is upon the antero-internal side of the humerus about a centimeter distal to the head. This insertion is tendinous and some 6 mm. long. Antero-dorsally this great investing sheet is more or less continuous with the thin muscular and tendinous sheet of trapezius muscles that covers the top of the head and neck and inserts along the anterior length of the scapular spine. Posteriorly the panniculus merges into a thin sheet investing the thigh as far as the knee and backward around the base of the tail. It is everywhere closely connected to the skin.

A flat strand of muscle from 2 to 5 mm. wide (Plate 4, fig. 1, *e*) arises from above the articulation of the 14th rib on each side and passes forward for about 60 mm. to become inserted into this great tendinous sheet some 30 mm. posterior to the axilla. This appears to be the *dorso-cuticularis*, and is apparently narrower than in Gymnura or Potamogale.

MUSCLES OF HEAD AND NECK.

Compared with Centetes, Gymnura, or Potamogale, the anterior muscles of the snout seem to show less complexity in Solenodon, but resemble more nearly those of Myogale as figured by Dobson, whose specimen of *Solenodon cubanus* was in too poor a state of preservation to permit of exact determination of these muscles.

The *platysma myoides* is a flat superficial muscle, well developed and firmly attached to the skin from the lambdoid crest forward along the sides of the face and lower jaw.

The *zygomaticus major* (Plate 5, fig. 1, *b*) is a relatively small muscle arising from the bony ledge of the antorbital pit just above the last premolar. It passes into a small round tendon at about the level of the anterior incisors, and running just to one side of the midventral line, inserts on the ventral portion of the tip of the cartilaginous proboscis. Its action is to depress the snout, but it evidently is of limited use, as the vertical play of the proboscis is not very great.

The *levator labii superioris proprius* (Plate 5, fig. 1, *c*) is a large muscle attached along the entire anterior edge of the orbit from the ventral border of the eye nearly to the dorsal line. It passes forward as muscle to the tips of the nasals where it becomes a flat tendon and runs to the tip of the proboscis below the median line.

The *levator labii superioris et erector vibrissarum* (Plate 5, fig. 1, *a*) originates anteriorly to the orbit, between the two muscles just described and ectal to the opening for the facial nerve. It is likewise more or less firmly attached to the antero-lateral face of the maxillary where it breaks into numerous small thread-like tendons that pass to the bases of the vibrissae with which the snout is well supplied. These fibers are firmly united by investing tissue and muscular strands to the side of the cartilaginous proboscis, to which they are undoubtedly able to impart a slight lateral motion. Ventrally this muscle is closely connected by tendinous tissue to the orbicularis oris. It is richly supplied with nerves.

Temporalis (Plate 5, fig. 1, *e*) is large, and arises along the median and parietal crests. Its main mass on the dorso-lateral surface of the skull is about 40 mm. long and 20 mm. broad. It passes ventro-laterally to a tendinous insertion at the tip of the coronoid process of the jaw and on its ental aspect.

A small muscle (Plate 5, fig. 1, *d*) arises from the lateral surface of the posterior zygomatic root and passes dorsal to the masseter as a narrow band some 5 mm. wide, to its insertion along the exterior base of the coronoid process for a distance of about 8 mm. This seems to correspond to what Dobson considers in Gymnura a second head of the temporalis. In Solenodon, however, it is quite separate from the temporalis throughout.

Another muscle, corresponding to Dobson's third head of the temporalis in Gymnura, arises much as in that form from the inner dorsal margin of the posterior zygoma, and curving downward and forward, is broadly inserted as a flat muscle in the hollow of the exterior face of the coronoid process.

The *masseter* originates along the posterior portion of the malar part of the zygoma for a distance of 7 mm., and is inserted along the postero-ventral surface of the ramus.

The *digastric* muscles (Plate 5, fig. 1, *f*) are rather small, arising along the inferior side of the lambdoid crests about a centimeter from the vertex of the skull. Each as it passes forward, tapers to a tendinous insertion at the tip of a small bony process on the inner ventral margin of the mandible about 13 mm. anterior to the angle of the jaw.

Pterygoideus internus is a short thickish sheet of muscle arising externally to the pterygoid on each side and inserting at the angle of the ramus.

Pterygoideus externus is smaller, and arises just externally to the last from the sphenoid region. It inserts on the lower jaw inside the neck of the mandibular condyle forward to the inferior dental foramen.

The *mylo-hyoid* arises as a thin sheet from the inner ventral margin of each ramus. There is a fairly well defined median raphe where the two elements, one from each side, are united. The fibers stretch across between the two rami, and posteriorly to the insertion at the antero-ventral margin of the basi-hyal. A deeper and a more superficial layer is with some difficulty to be distinguished in this muscle.

The *stylo-hyoid* is well developed and conspicuous. It is a narrow band arising from the ventral side of the mastoid process, and passing superficially to the digastric, is inserted on the side of the thyroid bone of the larynx. This muscle seems not to have been previously found in Solenodon. It is said

by Dobson to be "very feeble" in Centetes; but in Potamogale is well developed. Dobson's figure of the latter (Dobson, '82–'90, pl. 9, *st. h.*) shows this muscle in nearly the same proportions as in Solenodon.

The *sterno-hyoid* is the most ventral of the muscles of the throat. It arises from the inner or dorsal side of the second segment (mainly) of the sternum. This muscle is divisible into two elements, which, however, are so closely united in the mid-ventral line that the separation is not clearly defined until the investing tissue is removed. The sterno-hyoid is broadly inserted into the ventral surface of the thyrohyal cartilage.

The *sterno-thyroid* of each side is smaller than the corresponding sterno-hyoid, and arises just lateral to it. It passes forward along the side of the trachea to the thyroid cartilage, on to the side of which it is inserted by two short muscular branches.

The *crico-thyroid* is represented by short muscles on each side, that pass obliquely from the cricoid to the thyroid cartilage.

Beneath the mylo-hyoid on each side, from the symphysis for about 8 mm. posteriorly, arise the *genio-hyoids*. They are closely approximated medially and fill the space between the rami. They are inserted on the ventral side of the basi-thyrohyal.

The *genio-hyoglossus* is as usual, a thin flat sheet of muscle, arising from the basihyals and radiating out anteriorly to the tongue.

The *trapezius* muscles (Plate 4, fig. 1, *a*, *c*, *d*) arise along the mid-dorsal line from the vertebral spines to the occipital crest at the posterior edge of the skull, forming a broad thin sheet. They insert along the spine of the scapula beginning at about 15 mm. from its vertebral edge, forward for some 28 mm. A slight break indicates the division between the spino- and acromio-trapezius, but the latter and the clavo-trapezius are not clearly separable.

The *supracervico-cutaneus* (Plate 4, fig. 1, *b*) arises from the mid-dorsal line of the posterior half of the neck and passes ventrally to become confluent with the broad tendinous sheet attached to the skin along the front edge of the fore shoulder.

The *rhomboideus* arises underneath the trapezius, by two heads. The first consists of a single long band from the mid-dorsal portion of the neck from occiput to about halfway on its length. The second is a longer sheet from the last cervicals and first four or five dorsal spines. The muscle is inserted along the posterior inner border of the scapula from just below the angle along the entire vertebral margin. A similar partial division of this muscle was noted by Dobson

for *Solenodon cubanus*, and the homology of these two portions with the rhomboideus anticus and posticus respectively of Gymnura and Centetes is suggested. In Potamogale Dobson found these muscles coalesced to form a single sheet.

The *occipito-scapularis* (Plate 5, fig. 4, *b*) arises along the lambdoid crest for about 10 mm. lateral to the mid-dorsal line. It passes back to the postero-external face of the scapula about 6 mm. below the coraco-vertebral angle where it is broadly inserted along the vertebral edge of the scapula. Its length is about 80 mm.

The *sterno-mastoideus* (Plate 5, fig. 4, *g*) takes origin from the ventral surface of the presternum, where it is slightly overlapped by the ectopectoralis. It passes forward as a muscular band to a tendinous insertion at the lateral extremity of the lambdoid crest just above the ear. This tendon, as in Centetes and Gymnura is united with the tendon of the cleido-mastoideus as a common insertion. The *cleido-mastoideus* (Plate 4, fig. 4, *h*) takes origin from the antero-external edge of the ventral half of the clavicle.

The *levator claviculae* (Plate 5, fig. 4, *a*) is well developed and takes origin from the atlas only near the median line at the antero-ventral margin. It passes back as a narrow band to a tendinous insertion on the ectal edge of the metacromion just back from its tip.

The *splenius* arises along the dorsal line from about as far back as the fifth dorsal vertebra. Passing forward, it inserts along the mesial portion of the lambdoid crest from the vertex to just ental of the sterno-mastoid insertion. Anteriorly the portion arising from the first of the cervicals may be more or less readily separated from the posterior part of the muscular sheet.

The *complexus* arises from the transverse processes of the vertebrae from the fifth cervical to the sixth dorsal. It has the usual insertion under the splenius. A lateral and a more median portion may be distinguished.

The *rectus capitis posticus major* arises from just below the top of the neural spine of the axis and passes forward to its insertion beneath the lambdoid crest, in close union with the *rectus capitis posticus minor* whose origin is slightly more lateral.

The *obliquus capitis superior* originates from the tip of the transverse process of the atlas, and goes forward to its insertion below the lambdoid crest at a point about 7 mm. lateral to the vertex of the occiput. It is also united by a slight raphe to the ecto-proximal portion of the digastric muscle.

The *obliquus capitis inferior* is large and arises from the postero-lateral portion of the spine of the axis. Its course is obliquely forward to the posterior side of the transverse process of the atlas.

The *levator anguli scapulae* takes origin from the transverse processes of the three last cervical vertebrae and is inserted along the subscapular surface of the scapula, internal to the rhomboideus, from the coraco-vertebral angle to the insertion of the serratus magnus. In Centetes as in Gymnura and Potamogale this muscle is united with serratus magnus. In Myogale, however, the condition is practically the same as here described for Solenodon, though in the former the levator is slightly more developed.

MUSCLES OF THE TRUNK.

The *latissimus dorsi* (Plate **4**, fig. 1, *f*) is a large superficial muscle, consisting of a thin sheet of fibers covering the dorsal half of the thorax from the last rib forward to about the ninth rib. It arises from the spines of these vertebrae as well. Antero-laterally it becomes a narrow tendon which inserts on the antero-internal face of the humerus near its head, ental to the insertion of the teres and just above it. At the antero-ventral edge, just before the muscle passes into the tendon it is connected by a raphe with the epitrochlearis and by a few strong fibers to the ventral edge of the teres. This peculiarity was noted by Dobson in the Cuban Solenodon. Along the ventral edge of the latissimus where it covers the thorax, a branch from each of the dorsal nerves takes exit.

The *serratus magnus* has the usual general origin from the anterior portion of the thorax. Its posterior extension reaches the ninth rib. The muscle is inserted along the posterior inner edge of the scapula at the gleno-vertebral angle.

The oblique muscles present no especial peculiarities. The *ectobliquus* arises from the pubic symphysis on either side and passes upward and forward on to about the lower half of the ribs to the ventral border of serratus magnus, and the front of the ilium. The *entobliquus* has a strong tendinous origin from the anterior end of the ilium and along the pubis to the midventral line. It passes as a thin sheet antero-ventrally to the median line and ventral border of the ribs.

The *rectus abdominis* originates as a partly tendinous thin sheet from the ventral third of the first rib. It passes back to unite just behind the xiphisternum with its fellow of the opposite side, and the two are inserted by muscular fibers on the anterior rim of the pubis for a distance of about 8 mm. each side of the symphysis.

As in Gymnura, Centetes, and Potamogale there is a clavicular portion to the *ectopectoralis*. The sternal portion of this muscle takes origin along the entire median length of the sternum from the tip of the manubrium to the base

of the expanded cartilaginous end of the xiphisternum. The fibers converge as they pass obliquely forward to the insertion, 16 mm. in length, along the antero-median edge of the middle third of the humerus. The clavicular portion of this muscle (Plate 5, fig. 4, *c*) originates from the ecto-posterior border of the clavicle and is more or less confluent distally with the main mass of the ectopectoralis, though practically distinct to the common insertion.

The *entopectoralis* (Plate 5, fig. 4, *f*) arises just underneath the ectopectoralis, from the antero-ventral margin of the second rib, posteriorly to the base of the last sternal rib as a thin flat sheet, that becomes thicker as its fibers converge anteriorly to a tendinous insertion 4 mm. long at the head of the humerus, on its median face, just ental to the bicipital groove. At about the insertion of the fifth rib, there is a slight division of this muscular sheet so that its origin may be said to consist of an anterior and a posterior portion. These two parts evidently correspond to the two divisions described in Centetes by Dobson, although in that genus they are somewhat more extensive and distinct.

The *subclavius* (Plate 5, fig. 4, *d*) is a very narrow band of muscle arising from a tendon on the anterior side of the first rib, at about 2 mm. dorsal to the sternum. It passes antero-dorsally to a tendinous insertion on the ental aspect of the clavicle just proximal to its articulation with the acromion. This muscle is about 30 mm. long and 2 mm. or less in width. In Centetes, according to Dobson, it is not present, but in Gymnura is developed about as in Solenodon.

About 3 mm. dorsal to the origin of subscapularis, is the large tendinous insertion of *scalenus secundus* or *anticus*. It arises from the transverse processes of all the cervical vertebrae except the atlas, by tendinous and muscular fibers.

Scalenus primus arises dorsally to the last, from the transverse processes of the 3d, 4th, and 5th cervicals and is inserted on the thorax as far back as the fourth rib, in close juxtaposition to the ventral border of serratus magnus. The brachial plexus takes exit between the two scaleni.

The scalenus muscles appear thus to be much like those of Centetes and Potamogale, and differ from those of Gymnura and Erinaceus in that the *anticus* is present, whereas in the last two, according to Dobson, it is absent.

MUSCLES OF THE FORE LIMB.

The *coracoideus* (Plate 5, fig. 5, *c*) arises by a conspicuous tendon from the ental face of the coracoid process. The caput breve is inserted on the inner mesial surface of the humerus at a point 13 mm. from its head; the caput longe passes as a tendinous band from 2 to 3 mm. wide expanding somewhat distally to its insertion on the postero-internal portion of the humerus just proximal to the epitrochlea. Dobson makes the brief statement that this muscle in Solenodon is very similar to that in Erinaceus and Centetes. In Gymnura and Myogale the muscle was not detected, while in Potamogale the caput longe was wanting.

The *subscapularis* (Plate 5, fig. 5, *a*) is strongly developed. It is attached on the subscapular surface of the scapula, and arises from three rather distinct sets of fibers: (1) a set originating along the coraco-vertebral margin of the scapula nearly to the coraco-vertebral angle; (2) fibers from the vertebral margin of the scapula near the insertions of levator anguli scapulae and serratus magnus; (3) a bundle of fibers arising along the glenoid margin of the scapula, partly on the ental surface of the latter. Tendinous fibers from these three divisions run forward as a large tendon to an insertion on the trochin of the humerus underneath that of the coracoideus.

The large *supraspinatus* (Plate 5, fig. 6, *i*) is from almost the entire supraspinous fossa except its most posterior portion, from the coraco-vertebral margin to the margin of the mesoscapula, becoming tendinous as it passes under the acromion to its insertion on the trochiter.

The *spino-deltoideus* arises along the mesoscapula from just posterior to the metacromion. It passes forward and slightly inward, to its insertion on the crista deltoidea of the humerus. Here it is joined by the *acromio-deltoideus* from the infraspinous border of the acromion, a smaller, narrower muscle.

The origin of the *infraspinatus* (Plate 5, fig. 6, *h*) is underneath that of spino-deltoideus, from the whole length of the infraspinous fossa, except at the gleno-vertebral angle, where it meets and partly unites by a raphe, with the teres. Its tendon inserts on the trochiter, adjacent to that of the supraspinatus, but slightly distal to it.

The peculiar relations of the *epitrochlearis* (Plate 5, fig. 5, *d*) have been described by Dobson in *Solenodon cubanus* and they are the same in *S. paradoxus*. This muscle arises from a raphe about 18 mm. long, from the commencement of the tendinous portion of the latissimus dorsi. It is also connected at this point by a few fibers from the teres. The insertion is at the olecranon.

The *micostalis* (Plate 5, fig. 6, *a*) or "teres minor" is a small muscle, intimately associated with the infraspinatus. Its origin is from the glenoid border of the scapula, back about 11 mm. along the glenoid margin. Its insertion is by a very short tendon just distal to the insertion of the infraspinatus on the trochiter. According to Dobson, this muscle is lacking in Centetes, Gymnura, and Potamogale. It is present, however, in Erinaceus and largely developed in Myogale.

The *meditriceps* (Plate 5, fig. 6, *b*) is a large, prism-shaped muscle, from nearly the anterior third of the glenoid margin of the scapula. It tapers distally to a short tendon inserted on the olecranon.

The *ectotriceps* (Plate 5, fig. 6, *c*) arises from a sheet of tendon on the proximal part of the crista deltoidea. It is a flat muscle and gradually increases in breadth to its insertion on the ectal face of the olecranon, anterior to that of the meditriceps, to whose tendons for the space of about a centimeter it is here intimately connected.

The *entotriceps* (Plate 5, fig. 6) is divisible into three fairly distinct parts. The first of these seems comparable with the intermedia and the caudalis divisions as present in the cat. In Solenodon these two divisions are not to be differentiated, but arise as a single muscle from the posterior side of the humerus just distal to its head. The insertion is by tendon on the entero-dorsal side of the olecranon as far as the sigmoid notch. A second division, probably homologous with the division cephalica of the cat, arises along the postero-external side of the distal half of the humerus and inserts on the ectal aspect of the olecranon, ental to the insertion of the ectotriceps. The third division is apparently the same as the division brevis, and consists of a short bundle of muscular fibers from the ectal surface of the epitrochlea to a tendinous raphe near the distal extremity of the division cephalica. The condition of the triceps muscle in Solenodon seems to be much the same as that described by Dobson for Gymnura, and one is led to infer that its relations are nearly identical in Centetes and Potamogale.

The *supinator longus* is absent in Solenodon, as in Gymnura, Erinaceus, Centetes, Potamogale, and the Talpidae.

The *biceps* arises by a single head, as a strong rounded tendon about a centimeter in length from the dorsal lip of the glenoid fossa and base of the coracoid process. Its main mass is spindle-shaped and flattened. Distally it passes into a tendon that is inserted mainly on to the ecto-dorsal edge of the ulna, just distal to the lip of the sigmoid notch; a slip of tendinous tissue also connects

it with the proximal end of the radius at the point where radius and ulna meet at the articulation with the humerus. This is the condition likewise in Centetes, and practically that found in Gymnura, where, however, only the ulnar insertion is described. In Dobson's specimen of *Solenodon cubanus* he found *two* heads to this muscle. The second he describes as "a long and very slender tendon from the coracoid process immediately above that of the *coraco-brachialis*." This, he states, "becomes muscular low down, and unites with the belly of the glenoid head about the commencement of the lower third of the humerus; the muscle thus formed terminates in a tendon which is mainly inserted into the radius." Possibly the double origin of the biceps in his specimen was an individual anomaly, or the condition in the Cuban species is different from that obtaining in *S. paradoxus*.

The *brachialis* does not differ essentially from that of Gymnura and Centetes. It arises from the posterior side of the humerus between the two tuberosities and along the ectal margin of the crista deltoidea to insert into the capsular ligament and the inner dorsal edge of the radius.

The *extensores* (*carpi*) *radialis longior et brevior* (Plate 6, fig. 5, *b*) are not separate muscles, but form a single rather flat muscle that originates from the antero-proximal portion of the epicondylar ridge. At about the beginning of the distal third of the radius this muscle becomes a thick tendon that passes ental to that of the extensor ossis metacarpi pollicis, and splits into two tendons that go to the bases of metacarpals 2 and 3 respectively.

The *extensor digitorum communis* (Plate 6, fig. 5, *a*) arises by tendinous fibers from the ectal point of the epicondylus. Near the distal end of the radius it passes into a flat tendon that breaks directly into four small branches, one each to the dorsal surface of digits 2 to 5.

Just distal to the origin of the last, arises the *extensor minini digiti* (Plate 6, fig. 5, *g*) from the ectal edge of the epicondylus and from tendinous fibers from the communis and the extensor carpi ulnaris. It passes into a strong tendon that divides into two branches at the metacarpals. The ectal branch passes to the dorsal side of digit 5 and the ental branch dips under the outermost division of the communis to insert on the ecto-lateral face of the last phalanx of digit 4. This condition is essentially that in Centetes.

The *extensor carpi ulnaris* (Plate 6, fig. 5, *e*) arises just distal to the origin of the preceding, at the outer distal edge of the epicondylus and from fibers along the greater sigmoid notch. At about 18 mm. from its insertion it becomes a thick round tendon, passing to the ecto-proximal margin of metacarpal 5.

In Centetes and Erinaceus this muscle is said to be inserted into a sesamoid at the base of metacarpal 5.

The *indicator* (Plate 6, fig. 5, *f*) arises from an origin about 25 mm. long by muscular fibers along the ectal border of the ulna beginning near the distal edge of the sigmoid notch. The muscle then passes across to the ental aspect of the forearm, through the groove between the distal ends of the radius and ulna as a flat narrow tendon. At the carpal region the tendon divides into two, the more ental of which passes to a tendinous insertion about the dorsal base of the first phalanx of digit 1; the more ectal branch goes to a similar insertion on the ecto-lateral aspect of the first phalanx of digit 2. A similar condition is found in Erinaceus and Centetes.

The *extensor ossis metacarpi pollicis* (Plate 6, fig. 5, *d*) arises by muscular fibers along the approximated edges of radius and ulna from the region of the greater sigmoid notch, distally to within 5 mm. of the carpus on the ulna and to within about twice that distance on the radius. It then passes as a tendinous band, obliquely over the distal surface of the radius to the base of an elongated sesamoid bone on the ental side of the carpus, and to the ento-lateral aspect of the base of the first metacarpal. The relations of this muscle are said to be the same in Centetes.

The *pronator teres* (Plate 6, fig. 5, *c*) has its origin by short tendinous fibers from the epitrochlea and passes ectally as a flat sheet to a long tendinous insertion on about the middle third of the dorsal edge of the proximal portion of the radius.

The *flexor carpi radialis* (Plate 6, fig. 6, *b*) is from the anterior border of the epitrochlea, arising by tendinous fibers as a long, spindle-shaped muscle. This passes into a round tendon whose insertion is at the ventral ental side of the base of metacarpal 3. Dobson does not mention this muscle in Centetes, but states that in Erinaceus and Potamogale it goes to the base of the second metacarpal. Its condition in *Solenodon paradoxus* is thus more nearly that found in the cat, in which a small branch passes also to the first metacarpal.

The *flexor carpi ulnaris* (Plate 6, fig. 6, *c*) arises from the internal condyle of the humerus and is inserted by a strong tendon into the pisiform bone as in Erinaceus, Potamogale, and Centetes.

The *flexor sublimis digitorum* (Plate 6, fig. 6, *a*) is a narrow flat muscle whose origin is wedged in between the heads of the flexor profundus digitorum. It arises as a flat tendon about 12 mm. long from the anterior surface of the epitrochlea, about one or two millimeters from the ental margin. The muscular

portion becomes trifid distally, and each division sends a tendon to the second, third, and forth digits respectively. This tendon bridges the groove of the profundus.

The *flexor profundus digitorum* (Plate 6, fig. 6, *d*) arises as in Gymnura and Centetes from five heads, and thus differs from that of Potamogale in which but three are described. The first of these heads is superficial, from the anterior edge of the epitrochlea; its large tendon inserts into the common tendon on the radial side at the wrist. This division is more or less distinct throughout its distal union with the main mass of the tendon and has been homologized by Dobson with the *flexor longus pollicis*. Two smaller muscles, forming the second and third heads, arise in close association from the anterior surface of the epitrochlea and the anterior edge of the great sigmoid notch. Their tendons become confluent and join the main palmar tendon medially proximal to the insertion of the first division. The head of flexor sublimis separates the head of the first division from the common origin of the second and third. The fourth head arises as a large fleshy muscle along the ectal side of the ulna from the olecranon to within about 15 mm. of the distal end of the ulna where its fibers merge with those from the fifth division whose origin is from the proximal two thirds of the ental border of the radius. These five divisions unite to form a thick flat tendon at the wrist. This divides at the base of the metacarpals to form the usual five branches, one to the lower surface of each digit. This muscle in Solenodon seems most nearly to resemble that of Gymnura in possessing five distinct heads. In Centetes the condition is essentially similar, but the closely associated second and third heads are united into a single division. In Potamogale the number of heads seems to be still further reduced.

MUSCLES OF THE HIND LIMB.

The *psoas magnus* (Plate 4, fig. 2, *o*) appears to be essentially similar in its relations to that of Gymnura, Erinaceus, and Centetes. It arises from the transverse processes of the lumbar vertebrae as a thick muscular mass and becomes confluent with the iliacus from the ventral side of the anterior ramus of the ilium. It then tapers to its insertion on the lesser trochanter of the femur.

The *psoas parvus* (Plate 4, fig. 2, *p*) arises as a flat ellipsoidal muscle from the ventro-lateral portion of the first lumbar and the anterior portion of the second lumbar vertebrae. It then passes posteriorly as a thin flat tendon from 2 to 3 mm. wide and 30 mm. long to insert on the anterior edge of the pelvis, just

anterior to the origin of the pectineus. This muscle is thus closely similar to that of Erinaceus, Centetes, and Myogale, having apparently much the same proportions, origin, and attachment. In Potamogale and Gymnura it is very much larger in relative size and extent of origin, and is remarkable in the latter on account of its insertion upon the lesser trochanter together with the psoas magnus.

The *gluteus maximus* (Plate 6, fig. 1, *c*) arises as a thin muscular sheet by tendinous fibers along the dorsal border of the ilium and the dorsal spines from the fourth lumbar to the first caudal vertebra. A very distinct and separate portion of this muscle (Plate 6, fig. 1, *m*) arises from the anterior tuberosity of the ilium, just back of its dorso-lateral edge and passes postero-ventrally to join the anterior edge of the main mass of the maximus about a centimeter dorsal to the common tendinous insertion into the prominent crest below the great trochanter and some 15 mm. from the head of the femur. This peculiar second head may be an anomaly. Dobson does not mention it in his account of the muscles of *Solenodon cubanus*. In Gymnura the gluteus maximus is described as having a continuous origin "from the whole anterior margin of the ilium," a condition from which that in Solenodon just described might readily be derived.

The *gluteus medius* (Plate 6, fig. 1, *b*, *n*) arises as in Gymnura, Erinaceus, and apparently Centetes, from two heads, here, however, with difficulty distinguishable, from the entire outer face of the anterior portion of the ilium as far back as the level of the third sacral vertebra. The more anterior part is thick and fleshy; it inserts by tendon on the antero-dorsal portion of the great trochanter. The more posterior division inserts somewhat more distally on the posterior part of the great trochanter. The great sciatic nerve takes exit at the hinder margin of the first part of this muscle and is slightly overlapped by the second.

The *gluteus minimus* (Plate 6, fig. 1, *a*) is small and flat, from an origin about 14 mm. in length on the ischium beginning just above the acetabulum. It is inserted by tendinous fibers on the great trochanter, entero-posteriorly to the two other glutei. This muscle agrees with that of Gymnura in its more posterior origin; in Erinaceus it arises from the ilium.

The *rectus femoris* (Plate 6, fig. 1, *l*) is from a short tendinous origin some 4 mm. long from the postero-ventral margin of the ilium just anterior to the acetabulum. It is inserted on the antero-internal edge of the patella.

The *vastus externus* (Plate 6, fig. 1, *k*) has a long origin from the great trochanter and the trochantal ridge nearly to the distal end of the femur, and

passes into a tendinous insertion on the ectal side of the dorsal margin of the patella.

The *crureus* (Plate **6**, fig. 1, *j*) arises along the anterior margin of the femur and is almost inseparably united to the vastus externus. It inserts medially on the patella beneath the insertions of the vastus externus and the rectus femoris.

The *vastus internus* (Plate **4**, fig. 2, *b*) is distinct, instead of being fused with the crureus as in Gymnura. Its origin is from the antero-ental side of the proximal third of the femur, and its insertion is at the ento-dorsal corner of the patella.

The *pectineus* (Plate **4**, fig. 2, *n*) is a thick muscle somewhat triangular in section. Its origin is just dorsal to that of the adductor longus for about 9 mm. on the anterior rim of the pelvis and posteriorly nearly to the acetabulum. It is visible superficially for but a slight space, and passes beneath the surrounding muscles to its insertion as a somewhat tendinous sheet on the inner posterior length of the femur from the lesser trochanter nearly to the distal head. It is thus slightly more developed than in Gymnura.

The *quadratus femoris* (Plate **4**, fig. 2, *h*) is large, from an origin 19 mm. long on the posterior edge of the ischial tuberosity, covered by the adductor magnus and the semitendinous. It is inserted by a tendon on the lesser trochanter and the intertrochanteric fossa. Its relations are closely similar to those in Potamogale and Centetes. No connection with adductor brevis was found such as is described for Gymnura.

The *obturator externus* arises from the membrane covering the obturator foramen and from the bone bordering it. The insertion is by tendon into the trochanteric fossa posterior and ental to the great trochanter. This muscle is essentially similar to that of Gymnura, Centetes, Potamogale.

As pointed out by Dobson, Solenodon differs from Centetes and agrees with Gymnura, Potamogale, Erinaceus, and Myogale in the absence of an *obturator internus*.

The *gracilis* (Plate **4**, fig. 2, *g*) is large and arises from the dorsal half of the posterior margin of the ischium. It is somewhat pyramidal at first, becoming a flat muscular sheet just below the head of the tibia along its antero-internal border. As noted by Dobson, the gracilis muscles of the two sides of the body are well separated in Solenodon and related genera, but united medially in Centetes. No accessorius portion of this muscle was observed.

The *biceps femoris* (Plate **6**, fig. 1, *i*) is from two heads. Of these, the larger is from the ischial tuberosity, while the smaller consists of a flat tendinous mem-

brane from the spines of the two first caudal vertebrae. The two branches shortly unite to form a broad thin tendinous sheet that inserts on the ectal portion of the head of the tibia and condyle of the femur. Its condition is thus practically as in Gymnura. In Centetes and Potamogale the insertion is upon the fibula.

The *semitendinosus* (Plate 6, fig. 1, *d*) arises in a somewhat similar way by two heads: one by tendinous fibers from the dorsal spines just posterior to the origin of the dorsal branch of the biceps; the other from the tuberosity of the ischium posterior to the biceps. These two heads unite to form a single sheet of muscle that passes to an insertion some 9 mm. in length on the antero-ental side of the tibia, 22 mm. below its head. It resembles the same muscle in Centetes, Potamogale, and Myogale, rather than in Gymnura.

The *semimembranosus* (Plate 4, fig. 2, *d*) is very large and divisible into two portions. The first is a narrow band from the postero-ventral portion of the tuberosity of the ischium, passing to an insertion on the inner distal tuberosity of the femur. The second portion is the larger, and arises from the entire posterior border of the pelvis. It is inserted by short tendinous fibers on the ental aspect of the tibia for a distance of 11 mm. from its proximal head. This muscle is essentially like that of Centetes in its attachments. In Gymnura and Potamogale it is less extensive in origin and has but one head.

The *sartorius* is absent, as also in Centetes and Potamogale according to Dobson, who found it feebly represented, however, in Gymnura. Leche (:02) considers this muscle well developed in the last named.

The four adductores are well developed and quite separate. The *adductor longus* (Plate 4, fig. 2, *c*) is a rather narrow band, arising from the anterior edge of the pubis, just ventral to the origin of the pectineus. It inserts as a tendinous sheet on the ental surface of the inner condyle of the femur. Dobson describes in *Solenodon cubanus* a second small slip passing to the femur at the middle third of the shaft, but no such part was found in *S. paradoxus*, which therefore resembles Potamogale in respect to this muscle. In Gymnura and Centetes, however, Dobson describes a long insertion nearly the whole length of the femur, so that the condition he describes in *S. cubanus* is intermediate between that of Gymnura and Centetes on the one hand, and *S. paradoxus* and Potamogale on the other.

The *adductor brevis* (Plate 4, fig. 2, *c*) arises under cover of the gracilis from the ventral portion of the pubis and ischium. It is inserted by tendinous fibers for a distance of about 10 mm. along the distal third quarter of the femur on its

posterior side. This muscle in Centetes is similar but with a rather more extensive distal insertion, while in Gymnura the insertion is nearer the proximal end of the femur.

The *adductor magnus* (Plate 4, fig. 2, *m*) is small. It is a thin narrow strip arising from the tuberosity of the ischium under the biceps, and passes to an insertion under cover of that of the adductor longus on the internal condyle of the femur. This muscle shows a less developed condition as compared with that of Gymnura and Centetes. The peculiar insertion into the inner head of the gastrocnemius described by Dobson in Potamogale, he believes is a special modification correlated with the animal's habit of drawing the hind leg up against the tail when swimming.

The origin of *adductor quartus* (Plate 4, fig. 2, *k*) is under cover of that of adductor brevis from the ventral portion of the pubis and ischium, but its posterior extent is less at the ventral margin. It increases slightly in breadth as it passes over the lesser trochanter to insert on the proximal third of the femur along the ento-posterior side of the great trochantal ridge nearly to the proximal insertion of the adductor brevis. In Centetes and Potamogale according to Dobson, this muscle presents the same relations, but it appears to be absent in Gymnura.

The *gastrocnemius* (Plate 6, fig. 1, *c*; fig. 4) is a large muscle arising by two heads as usual. The first is from the posterior side of the external condyle of the humerus, by a stout tendon in which there is a small sesamoid bone; the second is from the internal condyle just proximal to the insertion of a portion of the semimembranosus to which it is joined by a few fibers. The great nerve trunk of the leg passes between these two heads. The insertion is as usual by the tendon of Achilles into the calcaneum at its posterior end.

The *soleus* (Plate 6, fig. 4, *a*) shows an interesting relation, and one apparently not observed by Dobson in *Solenodon cubanus*. It arises by tendinous fibers from the ecto-posterior edge of the head of the fibula, and becomes fused with the ectal portion of the gastrocnemius above its passage into the tendon of Achilles. A similar condition is found in Gymnura and Potamogale, but apparently not in Centetes.

The *plantaris* resembles that of Centetes in being inseparable from the gastrocnemius at its origin. Its tendon is apparent, however, on the ento-lateral side of the gastrocnemius. In Gymnura and Potamogale the origin is described as distinct from that of the latter.

The *popliteus* arises as usual from the thick tendon investing the ectal side

of the condyle of the femur. It passes obliquely as a triangular muscle to insert upon the postero-ental surface of the tibia just proximal to the origin of the tibialis posticus. There is a large sesamoid in the tendon of origin, attached by fibers between the heads of tibia and fibula.

The *tibialis anticus* (Plate 6, fig. 1, *h*) arises from the large shallow fossa on the ectal side of the tibia and the adjacent portion of the fibula. The muscle is triangular in section and becomes a strong flat tendon distally, that passes to the ental side of the foot through the same loop as the extensor longus digitorum. It is inserted on the ento-lateral side of the base of the entocuneiform bone, not on the rudimentary first metatarsal as in some mammals, *e. g.*, the cat, or the metatarsal of the first digit as in Gymnura, Potamogale, and apparently Centetes. Dobson does not mention the connections of this muscle in *Solenodon cubanus*. In *S. paradoxus*, however, this termination was carefully verified on both hind feet. The inserting tendon is large and conspicuous and is inserted back from the anterior edge of the bone.

The *extensor longus digitorum pedis* (Plate 6, fig. 1, *g*) is a very small narrow muscle, hardly 2 mm. in radial thickness, and less than that in superficial breadth. Its origin is from the tendinous sheath covering the ectal aspect of the condyle of the femur. Its tendon passes through a loop on the anterior part of the ankle together with the tendon of the tibialis anticus, then through a second loop enclosing the extensor alone, which here has broken into four appressed thread-like branches, one to each of the digits, 2, 3, 4, and 5. The branch to digit 5 is inserted at the ental, the others on the dorsal aspect of their respective digits. A similar arrangement is described for Gymnura and Centetes.

The *peroneus longus* (Plate 6, fig. 1, *f*) is very distinctly from two heads. The first is from the tendinous sheath covering the external condyle of the femur, continuous with the origin of the extensor longus digitorum. These tendinous fibers pass across to the second and principal origin about the head of the fibula. At a little more than one half the length of the tibia the muscle passes into a slender tendon, which dips under a loop at the ectal side of the ankle, then under a second loop on a prominence at the ecto-anterior portion of the calcaneum. It then gives off a small branch to the base of metatarsal 5 and continues across the foot to the insertion into the base of metatarsal 1. In Gymnura and *Erinaceus europaeus* it is merely inserted into the internal cuneiform, but in *E. jerdoni* according to Dobson ('82–'90, p. 55) the branch to the fifth metatarsal is also present. The insertion into the first metatarsal seems

to be a peculiarity not hitherto noted, but was unmistakably present in *S. paradoxus* and may be anomalous.

The *peroneus brevis* and the *peroneus quinti digiti* arise on the antero-external aspect of the fibula, the latter from the external aspect for a distance of about 11 mm. distal from the head, and the former more internal, for a slightly greater distance. The tendons of both are invested in a common sheath and pass together posterior to the external malleolus and beneath the tendon of peroneus longus. Peroneus quinti digiti is inserted into the distal phalanx of digit 5, while the peroneus brevis passes to the ecto-proximal end of the fifth metatarsal. Both these tendons are simple and show no trace of secondary divisions to digit 4 as described for Gymnura and Centetes by Dobson. Solenodon thus resembles Potamogale in the single attachments of these muscles.

The *extensor hallucis longus* arises from the middle third of the fibula and adjacent interosseus ligament and passes to the distal phalanx of digit 1 on the dorsal side, through the same large groove on the front of the ankle, as the extensor longus digitorum and the tibialis anticus.

The *tibialis posticus* (Plate **4**, fig. 2, *j*) is concealed by the flexor longus digitorum. It arises from the proximal end of the fibula on its posterior side and is more or less connected by muscular fibers with the flexor longus hallucis. After crossing to the ental aspect of the limb, it passes as a small tendon through a groove on the distal part of the tibia to the insertion into the ento-lateral process of the os calcis at its anterior end, not into the naviculare or scaphoid as commonly. Dobson states that this muscle in *Solenodon cubanus* retains its usual insertion into the naviculare, but in *S. paradoxus* it was found on each side, inserted unequivocally as above noted.

The *flexor longus digitorum*, or *digitorum tibialis* (Plate **4**, fig. 2, *l*) arises mainly from the posterior proximal portion of the tibia. The tendon passes through the same groove on the ental aspect of the tibia as that of the tibialis posticus, and ectal to it. It becomes inserted into the ventral surface of the flexor longus hallucis. At the base of the carpals, it gives off a small branch to the rudimentary first metatarsal. This muscle in Solenodon resembles the corresponding one in Potamogale, rather than that of Centetes whose curious development has been described by Dobson. In Gymnura it is merely united with the next.

The *flexor longus hallucis* (or *digitorum fibularis*) (Plate **4**, fig. 2, *i*) takes origin from nearly all but the distal portion of the posterior side of the fibula and adjoining middle third of the tibia. It is much larger than the flexor

digitorum tibialis. Distally it passes into a strong tendon that runs along the ventral groove of the os calcis and spreads out over the sole of the foot. Here it is joined by the tendon of the flexor longus digitorum or tibialis and then sends a large tendon to the ventral surface of each digit.

Two short stout tendons bind the foot to the bones of the lower limb. The one is from the distal end of the fibula at its ectal margin and passes to the dorsal edge of the os calcis posterior to the articulation with the astragalus. The second tendon is on the ental side from the anterior edge of the tibia to the proximal end of the naviculare.

MUSCLES OF THE TAIL.

The tail of Solenodon is capable of almost no lateral movement, but may be slightly elevated and depressed. In section it is nearly quadrangular proximally after the skin has been removed to expose the muscle masses. These are chiefly four.

The *levator caudae internus* is the most dorsal, and is continuous with the semispinalis of the back. It passes dorsal to the metapophyses, and breaks into tendinous threads that form a distinct bundle running the length of the dorsal side of the tail. On the distal two thirds of the tail these tendons become inserted on the anterior zygapophyses. This mass of fibers is joined by small tendons from muscles that arise from the metapophyses of the caudal vertebrae and by others from the dorsal portion of the vertebrae between the spines and the zygapophyses. The tendinous bundle resulting from these fibers, tapers to the extremity of the tail and forms the dorso-lateral angle of the tail.

The *levator caudae externus* is smaller. It is a bundle of small muscles that arise by tendons from the median edge of the anterior portion of the ilium and from the metapophyses of the sacrum. These unite and pass distally as a thin lateral bundle connecting the metapophyses of the caudal vertebrae.

The ventral musculature of the tail is mainly from the *sacro-coccygei*, one on either side of the mid-ventral line, below the metapophyses. These arise each as an elongated mass from the ventral side of the sacral vertebrae, medially. Just distal to the ischium they pass into strong tendinous strands that shortly form a rounded compact bundle, tapering to the distal end of the tail. This bundle forms the ventro-lateral angle of the tail on each side as seen in section, and fills the space between the chevron bones and the metapophyses.

Ventrally a small muscle arises from the posterior end of each chevron bone

on either side. It passes externally to the next posterior chevron bone as a small tendon and inserts into the antero-ventral end of the chevron bone next succeeding. Each muscle therefore skips one chevron bone and inserts upon the next but one posterior to its origin.

OSTEOLOGY.[1]

The cranial characters of Solenodon are now well known. The original skull described and figured by Brandt ('33) was incomplete, having lost the occipital portion. In his recent paper on this animal, Dr. J. A. Allen (:08) has given photographic reproductions of the skulls of old and young. The superior outline of the skull is nearly flat, becoming slightly depressed posteriorly. The sagittal crest is slightly developed on the posterior half of the skull but in the specimens examined was barely over a millimeter in greatest extent vertically over the condyles. The lambdoid crests are greatly developed and overhang the foramen magnum about 5 mm. The maxillary region increases gradually in depth from behind the large first incisors to the molars, where it abruptly deepens to the last molar. This depth is retained to the mastoid region, then becomes slightly less. The lachrymal foramen is very large, and only 2 mm. dorsal to the great antorbital foramen. There are several (4 or 5) small foramina above the mastoid process for the passage of vessels. In dorsal aspect, the most striking peculiarities of the skull are: the deep emargination of the nasals, with their median point some 4 mm. posterior to the anterior end of the intermaxillaries; the long, parallel-sided snout, occupying slightly more than one third the length of the skull; the elongated brain-case, slightly contracted at the middle of the orbit, then expanding at the mastoid region and ending in a parallel-sided and abruptly truncated occiput. There is a diastema between the first and second incisors, at which point is a depression on each side in the floor of the palate. The two incisive foramina are at the medial border of each pit, and measure 2 mm. in length. The palate is nearly parallel-sided on the rostral portion, and expands distally. Minute foramina occur at the ental bases of the teeth and posteriorly near the median region but otherwise the palate is entire in our specimen. The interpterygoid fossa is deep, and slightly convergent posteriorly, thus differing from that of *S. cubanus* in which these walls diverge. The hamular processes of the pterygoids are short but sharply con-

[1] Since this account was prepared, W. K. Gregory has published a description of the skeleton of *S. paradoxus* (see Bull. Amer. mus. nat. hist., 1910, **27**, p. 241–255).

vergent. A small projection of the palate forms a minute tooth medially at the posterior edge of the palate. The tympanic bone is a nearly complete narrow ring, not fused with the mastoid portion of the periotic, but meeting it for a space of about 3 mm. along the ecto-posterior edge. At the antero-lateral termination of the tympanic is the large fissura Glaseri as a groove on the posterior side of the post-glenoid process. There are two large foramina between the ental end of the latter and the pterygoids, the more anterior of which appears to correspond to the foramen rotundus and the more posterior, which is slightly the larger, to the foramen ovale. The zygomata are incomplete. The round flat bone, fastened by ligament to the anterior end of the intermaxillaries at the ventral edge of the nasal cavity was noted and described by Brandt in his paper of 1833. It serves to support the base of the cartilaginous proboscis and was termed by Brandt the os proboscidis. It is lacking in *Solenodon cubanus*. It is nearly circular and about 5 mm. in diameter in our specimen.

The teeth have been thoroughly described by Brandt, Peters, Dobson, Leche, and more recently by J. A. Allen, who has figured the milk dentition. The tooth formula is $I\frac{3}{3}\ C\frac{1}{1}\ P\frac{3}{3}\ M\frac{3}{3}$. In addition to the smaller size of the teeth, those of the Cuban species differ conspicuously in the presence of a diastema nearly 2 mm. long between the third upper incisor and the canine; in the absence of an anterior cingulum cusp on the upper canine; and in the form of the second upper premolar, which in the Cuban animal has a prominent ento-posterior angle giving a nearly triangular basal section to that tooth, whereas in *Solenodon paradoxus* this angle is not developed and the tooth is nearly oval in outline. All the teeth of the lower jaw are in contact in both species. The last lower molar of *S. paradoxus* shows a slightly greater relative development of the posterior cusp than that of *S. cubanus*. The remarkable resemblance in the form of the skull and teeth of Solenodon to those of Myogale was noted by Brandt. The general resemblance in external form as well, suggests that in these respects Myogale is a generalized member of the Talpidae that has acquired a further development of the molariform teeth from the primitive tritubercular condition of the crowns to the more specialized W-shaped type of crown. In these respects and in certain points of muscular development, Myogale probably stands in much the same relation to the rest of the Talpidae as does Gymnura to the others of the Erinaceidae. Both are generalized forms bearing many close resemblances to the more primitive Solenodontidae.

The remarkable deep groove of the large second lower incisor of Solenodon seems peculiar to this genus. In Erinaceus there is a shallow groove on the first

incisor at the internal side of the tip and a similar condition exists in the second lower incisor of Talpa.

The vertebrae of *Solenodon paradoxus* are: cervicals, 7; dorsals, 16; lumbars, 4; sacrals, 4; caudals, 24; total, 55. There is thus one more dorsal, one less sacral, and one less caudal than described for *S. cubanus* by Peters, whose account appears to be the only one on which our knowledge of the skeletal parts of *S. cubanus* other than the skull, is based. Dobson apparently follows Peters, though he states that his description of the myology is based on the dissection of a specimen from Cuba in the Paris Museum. Peters's figure is very clear, and the additional sacral vertebra in *cubanus* seems to be a caudal fused to the sacrum since the first chevron bone is between this fused vertebra and the next following caudal vertebra instead of between the first and second free vertebrae. In possessing 16 dorsals, *Solenodon paradoxus* resembles Potamogale. Gymnura has 15, as does *S. cubanus*, and certain species of Erinaceus. Centetes seems still more primitive in possessing 19, as does Chrysochloris. The lumbar vertebrae in Solenodon are reduced in number as in the latter genus, being but 4, and thus fewer than in the other generalized Insectivora. Centetes is remarkable in possessing but two sacrals, though *Solenodon paradoxus* with four only shows a reduced condition as compared with related genera. The following table will show at a glance these differences.

Vertebral Formulae of Insectivora.

	Cervicals.	Dorsals.	Lumbars.	Sacrals.	Caudals.
Gymnura alba	7	15	5	5	25
Erinaceus	7	14–15	6	7	6+
Talpa	7	13	6	5	12
Myogale	7	13	6	6	27
Potamogale	7	16	5	5	32
Centetes	7	19	5	2	7
Solenodon cubanus	7	15	4	5?	23?
Solenodon paradoxus	7	16	4	4	24
Chrysochloris	7	19	4	5	8–9

The atlas of Solenodon (Plate 7, figs. 4, 5) resembles that of Gymnura in possessing a ventral median hypapophysis extending posteriorly from the anterior lip, but the remaining vertebrae are without hypapophyses, thus differing from Gymnura and Potamogale. The axis is large with a high broad crest and elongated transverse processes at its ventral margin, directed posteriorly (Plate 7, figs. 8, 9). At the fourth cervical vertebra the transverse process has also an anterior projection which increases somewhat in the two succeeding.

In the 6th vertebra this process is produced axially forming a broad ventro-lateral ridge extending posteriorly beyond the edge of the vertebra itself. This condition is found in *Gymnura alba* of which a skeleton was examined. In Erinaceus the posterior extent of this process is less. In the seventh cervical this large process is normally obsolescent, but in one example of *Solenodon paradoxus* examined, it is equally divided between the 6th and the 7th cervicals so that a vertebral canal is abnormally present on the left side of the 7th cervical, but not on the right side.

The dorsal vertebrae in a general way resemble closely those of Gymnura. The spines of the three first dorsals increase successively in height, and measure from the anterior end of their proper bases, 11.5, 16, and 17 mm. respectively. These spines are high and somewhat circular in section, and expanded a trifle distally. In Gymnura the spine of the second dorsal is highest. The following spines from the fourth to the ninth decrease slightly in height, and become stouter and laterally compressed. All of the series are directed sharply backward. The spines of the tenth, eleventh, and twelfth vertebrae, however, are hardly tapered distally and curve distinctly forward at their tips. The thirteenth spine is nearly upright and the fourteenth is almost twice its length and points anteriorly. The two last dorsals have low spines whose tops are flat in profile and nearly as long as their centra.

The twelfth dorsal vertebra begins to develop a descending lateral point at the posterior end, that becomes a distinct diapophysis at the 14th vertebra and in the vertebrae succeeding. Beginning with the first lumbar (Plate 7, figs. 13, 14) however, the diapophysis instead of being directed posteriorly, is curved anteriorly from a base running the length of the vertebra on a level with the center of the spinal cord.

The four sacral vertebrae are solidly fused throughout, much as in Gymnura, and the continuation of the diapophyses forms a flange or shelf along the sides of the centra. The dorsal profile is slightly emarginate between successive spines of the fused vertebrae. The sacrum, in dorsal view is narrower near the middle of its length than at either end.

The caudal vertebrae (Plate 8, figs. 3, 4, 6) rapidly lose their dorsal spines, which are well developed in only the three first. The neural canal practically disappears with the ninth. The prezygapophyses of the fifth caudal are the last to form an articulation, for this and the succeeding vertebrae lack any trace of postzygapophyses. The prezygapophyses become successively reduced toward the tip of the tail, and become obsolete on the 16th or 17th vertebra.

At the sixth caudal the broad diapophysis is divided into an anterior and a posterior portion, the latter of which becomes obsolete at the 15th, and the former at about the 18th vertebra. In Gymnura the diapophyses are much less developed, having an anterior but not a posterior origin on each vertebra, while the prezygapophyses, in the specimen examined, end with the third caudal.

The chevron bones are largely developed, and as in Gymnura occur in connection with all but the few terminal vertebrae. In Gymnura, however, the two lateral elements of each chevron are unfused except in case of the second and third which are united at their origin medially. Their antero-posterior extent is much greater in Gymnura. In Solenodon the two lateral elements of the first chevron are thin terete spicules of bone, approximated distally but separate. The second chevron is similar but the two elements are fused both proximally and distally forming a closed canal for the caudal artery. The same condition prevails in the two following, whose distal parts are in addition expanded laterally. In all the succeeding chevron bones the arterial canal is open ventrally. The last chevron is between the 21st and the 22d caudals. In *Solenodon cubanus* Peters has figured but twenty chevron bones. There are 21 in *S. paradoxus*.

The ribs and sternum (Plate 7, figs. 11, 12) of Solenodon are remarkably strong and well ossified. The sternal portions of the first twelve ribs are bony, while the thirteenth is cartilaginous at the distal end only. The two succeeding ribs are connected by a cartilaginous strand to the ventral margin of the other sternal ribs, while the 16th rib is short and without such connection. The sternal portion of the first rib is broad at its articulation with the manubrium along the posterior curve of its antero-lateral expansion. The sternal portions of the three ribs following articulate each at the point of union of the first and second, second and third, and third and fourth sternal elements respectively The fifth rib is inserted at the junction of the fourth and fifth sternal elements, and its sternal portion is of two separately ossified pieces. The fifth sternal element serves for the attachment, directly or secondarily of ribs 6 to 14 both inclusive. The sixth and seventh ribs are inserted separately, one directly in front of the other; the latter has three bony portions ventral to the main dorsal shaft. The sternal portions of ribs 8, 9, 10, and 11, have each a proximal section about 13 mm. long, making nearly a right angle with the more distal portion running antero-internally to the sternum and forming the ventral rim of the thoracic basket. These more distal pieces of these ribs just mentioned, are fused into a single bony mass, on whose ectal surface may be traced the lines of union,

though on the ental face these lines cannot be seen. In Gymnura the sternal cartilages of but two ribs, the 8th and the 9th, are partly fused in this way. The terminal cartilages of ribs 12, 13, 14, and 15, are bound by connective tissue to the posterior rim of this large fused mass in *Solenodon paradoxus*. The extreme development of the sternal portion of the ribs in Solenodon is very remarkable and apparently not found in other Insectivora. In a skeleton of *Ericulus setosus* from Madagascar, however, a somewhat similar ossification of the sternal portions of the ribs is present, but there is not the fusion of the ventral elements in the posterior members.

The first thirteen ribs have a double articulation: by the capitellum to the point of union of the vertebra with the vertebra next preceding; and by the tuberculum to the lateral surface of the prezygapophysis. The tuberculum disappears with the fourteenth rib and the articulation is at the anterior end of the centrum of the respective vertebrae alone, not with the centra of two vertebrae.

The sternum is of six pieces. The manubrium is roundly expanded anteriorly. It is not keeled, but is slightly emarginate at the median extremity. It thus resembles that of Erinaceus and Ericulus, and differs markedly from that of Gymnura which is lozenge-shaped anteriorly, with a strong keel. The three sternal pieces following the manubrium are quadrilateral, each slightly longer than wide and narrower at the anterior end. The fifth piece is evidently a fusion of three elements, the last of which is the most reduced in width. The flat narrow terminal element (xiphisternum) is articulated to its dorsal posterior margin and bears a large oval cartilage distally.

Compared with the sternum of *Solenodon cubanus* as figured and described by Peters, that of *S. paradoxus* differs notably in possessing one less element. There are seven sternal pieces in the former and but six in the latter. This difference seems clearly to be due to the complete fusion in *S. paradoxus* of what in *S. cubanus* are the fifth and sixth pieces, so that in the former the penultimate element of the sternum gives attachment to three sets of ribs instead of but two as in the latter. The absolute length of the articulating segments of the sternum is thus some 6 mm. shorter in *S. paradoxus* than in the Cuban species, notwithstanding the greater general size of the former. A second difference is found in the shape of the xiphioid process which in *S. paradoxus* is simple, whereas in *S. cubanus* it is represented as of two lateral portions fused anteriorly.

The clavicles are large and slightly sigmoid in anterior aspect. They are united by membrane to the antero-internal extremities of the manubrium and curve, dorsal to the head of the humerus, to the dorsal edge of the tip of the acromion.

The pelvic girdle (Plate 8, figs. 1, 2) is much like that of Erinaceus in its proportions. The pubis is well developed, with a lateral crest for the attachment of muscles, and quite without the inward arching of the anterior rim so peculiarly developed in Gymnura. The symphysis is about 4 mm. long yet firm, as in Erinaceus. In Gymnura it is incomplete. The obturator foramen is large and subquadrate in outline. The ischial tuberosities are about as far apart as are those of the ilia. In absolute size the pelvis of *Solenodon paradoxus* is practically identical with that of *S. cubanus*. Leche (:07, p. 83, text fig. 77) has given a figure and description of what he believed to be "das bisher unbekannte Becken von *Sol. paradoxus*," but there can be no doubt that the bones figured (a pelvis, with sacral and four caudal vertebrae) are not those of Solenodon at all. The figures represent a pelvis larger than that of this genus, with a long symphysis pubis, oval obturator foramen, evenly rounded ischia, and caudal vertebrae of a totally different character from those found in Solenodon. Doubtless the mistake arose through some transposition of labels, for Leche himself remarks upon the astonishing characters that the specimen presents, quite different from those of all other "Insectivora lipotyphla."

The scapula (Plate 8, figs. 5, 7, 8) is subtriangular in outline, with a greater relative development of the coracoid margin than in Erinaceus. The scapula spine is broad and shelf-like but the acromion and metacromion are shorter than in Erinaceus and Gymnura, and in this respect resemble these processes in Centetes.

The humerus (Plate 8, figs. 9–11) is short and is remarkable for its great expansion distally, on each side of the articulation. The epitrochlear foramen is present as in Gymnura, Centetes, and Ericulus. This foramen is absent in Erinaceus. In the specimen of Gymnura examined, the olecranal fossa is perforate, but no such perforation was found in Solenodon, Ericulus, or Erinaceus, and it apparently does not exist in Centetes. The extreme length of the humerus is 49 mm. or about 5 mm. longer than that of *S. cubanus*; its least breadth is 5 mm. at about the commencement of the distal third of its length. The greatest distal expansion is 18.5 mm., of which the articulating surface occupies 7 mm.

The radius and ulna (Plate 8, fig. 15) are separate and practically as in the Cuban Solenodon. The former is narrow proximally with a distinct neck about 5 mm. from the articulation. Distally it is expanded and articulates with the radiale and the intermedium of the carpus. Its ectal face has a shallow longitudinal groove along the distal three fourths. Its extreme length is 41.5 mm., or about 5 mm. greater than the measurement of the same bone in Peters's

figure of *S. cubanus:* At its proximal end it is in contact with the ulna for a distance of 6 mm. along the lesser sigmoid cavity. The ulna is more slender in proportions and tapers distally. At the carpus its ental side is in contact with the radius, and it articulates with the ulnare. A deep groove commences below the sigmoid notch and runs nearly the entire length of the ectal face, becoming shallower distally. In Gymnura and Erinaceus, skeletons of which were available for direct comparison, this groove is but slightly developed. A much shallower groove is present on the ectal face of the ulna, but is barely indicated at the proximal end in the two genera just mentioned. The extreme length of the ulna is 54.5 mm., and thus but 2.5 longer than that indicated in Peters's figure, natural size, of the skeleton of *S. cubanus*.

The carpus of Solenodon (Plate 8, fig. 15) is of a very generalized character, and appears to be nearly identical in the two species of the genus. The proximal row of ossicles consists of radiale, intermedium, and ulnare, the two first of which lie side by side and articulate by their proximal faces with the radius; the ulnare is an isosceles triangle in dorsal outline, and articulates with the ulna only at its proximal side, while the base is in contact with the intermedium. The radiale has the greatest lateral extent of the three, and at its ental margin is produced as a rounded knob on the ventral side. A slight sulcus near the distal end of this projection may indicate a fused basal portion of the prepollex. The os centrale is a small compressed bone mainly in contact with the radiale but on its ectal margin touching the centrale and the third carpale. The distal row of carpals is of four bones, of which the most ectal or unciform represents as usual the fused fourth and fifth carpalia; it serves for the articulation of the fourth and fifth digits. The first, second, and third carpalia are separate bones, and give articulation to their respective metacarpals. The second metacarpal, however, has also a short articulation at the inner side of its base, with the first carpale. The prepollex is about 6 mm. long and nearly 2 mm. in greatest width; it is loosely attached by connective tissue at the base of the first digit. The pisiform bone is strongly developed at the ectal side of the carpus, and articulates with the ulnare and slightly with the distal point of the ulna.

In the generalized condition of the carpus, *Solenodon paradoxus* resembles Centetes, but is even more primitive in that it retains the radiale and the intermedium distinct instead of fused into one as in the latter. According to Dobson these two bones are fused in *S. cubanus* ("There is a scapho-lunar bone") but Peters's figure shows them as two separate ossicles. Gymnura and Potamogale in addition to the fusion of these bones, show a further reduction of the carpal elements through the loss of the os centrale.

The metacarpals and phalanges are large and strong and in relative length would be arranged in the order 3, 4, 2, 5, 1. The middle three digits are subequal, and have each three phalanges. The first and fifth digits are conspicuously shorter; the former has but two phalanges, but the latter has three. The claws are shorter in *S. paradoxus* than in *S. cubanus*. A pair of small sesamoids is present ventrally at the proximal end of the first phalanx of each digit. These as usual, form a groove for the great flexor tendon. A single median sesamoid is also present at the ventral articulation of the two terminal phalanges of each digit. In the pollex, however, it is very small.

The femur (Plate 8, figs. 12, 13) is much like that of Gymnura in shape but has a shorter shaft. Indeed, the shortness of the femur is remarkable. The lesser trochanter is about as well developed as the greater. A deep fossa occurs on the posterior side of the latter and is continuous with the broad intertrochanteric depression. A conspicuous sesamoid is present on the ectal side, at the posterior curve of the distal condyle; it lies in the ectal tendon of the gastrocnemius. The large, subquadrate patella measures 7.5 mm. in length. The greatest length from the proximal to the distal condyle of the femur is 47.5 mm.

Dobson states that in *Solenodon cubanus* the tibia and fibula are distinct, as in Centetes, Ericulus, Hemicentetes, and Tupaia although so closely approximated in the distal third that they might ankylose in aged individuals. Peters's figure also shows the two bones distinct in this species. In the adult *S. paradoxus*, however, the two are united distally for 18 mm., or about one third their length. The line of fusion is discernible, nevertheless, and a deep groove is formed between them, for the peroneus tendons. This point appears to be one of some importance, for all previous writers have emphasized the separation of tibia and fibula in Solenodon as a character possessed in common with Centetes, but not found elsewhere in the related families. It is not clear that the condition as thus described for *S. cubanus* is due to immaturity or individual variation, but certainly in adult *S. paradoxus*, the tibia and fibula are distally ankylosed as in Potamogale, except that in the latter the line of union is said to become quite obliterated with age. It should be mentioned, however, that in the skeleton of a young *S. paradoxus* examined, the tibia and fibula, though closely approximated distally are apparently separate, and in the skeletons of two fully grown though not old animals, these bones are but imperfectly fused along the line of contact. The antero-internal face of the tibia is rather flat proximally, but the crest at the ectal border of this flattened area is scarcely developed, in contrast with the condition in Gymnura in which a prominent crest projects

over a deep fossa. The fibula is of about the same absolute width as in Gymnura and articulates at its head with the ectal head of the tibia. It is therefore free proximally as, apparently, in Potamogale and Myogale, but not in Gymnura and Erinaceus. An oval sesamoid bone about 3.4 mm. in length occurs in *Solenodon paradoxus* attached by fibers to the approximated posterior edges of tibia and fibula. It lies in the popliteus muscle just below its origin from the femur. I have found no mention of such a bone in other Insectivora and it is not shown in Peters's figure of the skeleton of *S. cubanus*. The greatest length of the tibia is 63 mm., and of the fibula 58.5 mm., or almost identically the same as the corresponding bones of *S. cubanus*.

The bones of the foot (Plate 8, fig. 16), according to Dobson, are in general like those of Centetes. They also appear to be essentially similar to those of the Erinaceidae. There is, however, a remarkable development of the proximal portion of the entocuneiforme, whose ventral border is continued posteriorly so as to meet the antero-internal edge of the os calcis. This portion also articulates dorsally with the ental surface of the astragalus and passes ventral to the naviculare which thus rests partly upon it. The last-named is small and trapezoidal in shape, articulating with part of the distal face of the astragalus. The mesocuneiforme is about half the size of the ectocuneiforme and the two articulate with the second and third metatarsals respectively, as usual. The cuboid is large, and its expanded proximal end articulates with the os calcis. The fourth metatarsal is supported by its distal end, as likewise the ental corner of the fifth, which rests in part on the base of the former. There is a well developed prehallux of two separate bones. The more proximal is small and nearly round, about 1.5 mm. in diameter, at the ento-posterior edge of the naviculare. The more distal bone is flattened, about 5.5 mm. long, and slightly less than 2 mm. distally where it reaches its greatest breadth. Peters has figured a similar prehallux for the Cuban Solenodon.

The metatarsal of the hallux has a ventral outer projection at the base, that partially overlaps the base of the second metatarsal from the plantar aspect. A much less imbrication is shown by the base of the second and the fifth metatarsals. No such development was noted in Gymnura and Erinaceus.

The three middle digits, 2, 3, 4, are subequal in length; the fifth is shorter, and the first a trifle shorter still. This last has two phalanges, like the pollex. As in the manus, there are two small sesamoids at the base of all the proximal phalanges, and a minute median sesamoid ventrally at the last joint of each digit.

It remains to describe briefly the laryngeal and hyoid bones (Plate 7, fig. 3).

These appear to be similar to those of *S. cubanus* as figured by Peters ('64, Plate 2, fig. 11), and are well ossified. The thyroid is the largest, 13 mm. in greatest length. It is slightly more than half a complete ring and has at the anterior dorsal margin on each side a process for the articulation with the tips of the thyrohyals. Posteriorly, the dorsal margin is similarly produced to form processes articulating with the postero-lateral margin of the cricoid. A low ridge arises about midway of the straight dorsal border and curves ventrally to the posterior edge. Above it on each side is a minute foramen at the dorsal edge of the bone. On the left side in our specimen there is in addition a minute foramen about 2 mm. anterior to the first. The thyrohyal of each side has fused ventrally with the basihyal so that the three bones thus form a half ring, bowed back at first, then forward at the ventral side. The ceratohyals are appressed against the ventro-lateral margin of this ring. They are rather thick and about 4 mm. in dorso-ventral length. Their dorsal border, and the edge of the thyrohyal adjacent, articulate on each side with the epihyal, a broad but laterally flattened bone, that projects anteriorly from this articulation. This in turn joins with the stylohyal, which is about 2 mm. longer, and much more rounded and slender. It joins the skull by a very short bony process that projects at nearly right angles from its proximal end. This process may represent a fused tympanohyal. The cricoid at its anterior end is clasped by the converging posterior processes of the thyroid and is a complete bony ring, with a postero-dorsal extension. The vocal cords are attached by cartilage, one at each side from the anterior apex of this ring to its mid-ventral line, and pass forward as a delicate strand to a median attachment just back of the anterior edge of the thyroid. The first tracheal ring is the broadest and fits into the posterior end of the cricoid, to which it is bound by muscle fibers. Peters states that in *Solenodon cubanus* the first nine tracheal rings are complete and that there are 21 in all. In *S. paradoxus* the number is slightly more, 22 to 29, and all are incomplete dorsally. The closest approximation is anteriorly where the two ends of the partial rings are about 2 mm. apart.

VISCERAL ANATOMY.

Digestive system.— The surface of the palate is marked by transverse folds whose number seems commonly to be eight, omitting the ridge bounding the posterior end. The first is a short transverse ridge between the third incisors; the second is larger and passes across at about the middle of the canines; the

third begins at the anterior corner of the first premolar on each side and is bowed forward; the fourth and the fifth arise on the palate at the base of the second and third premolars respectively; finally, the sixth, seventh, and eighth join the anterior edges of the first, second, and third molars respectively. The amount of bowing forward varies slightly. Brandt, in his original account figures but seven, and Dr. J. A. Allen has recently described the same number in the specimen at New York. These may represent actual variations or, as seems probable, one of the folds may have become relaxed and thus have disappeared through partial maceration. It is the smallest and anteriormost fold that is lacking in Dr. Allen's specimen. Peters figures nine transverse folds for *S. cubanus*.

The tongue (Plate 9, fig. 4) is long, narrow, and tapering. It is free at the tip for about 19 mm., and closely resembles that of the Cuban Solenodon in the character and distribution of the papillae. These are of three principal kinds: first, the fungiform papillae, that are scattered over the surface of the tongue from the muscular prominences at its root, where they are most numerous, to the tip; they are white, and either round columnar projections or expanded at the top, and project conspicuously from the surface of the tongue; secondly, the circumvallate papillae of which there are three, one circular and median, just posterior to the swellings at the root of the tongue, and two oval, one on each side and slightly in advance of the median papilla; in Gymnura there is no median circumvallate papilla; and thirdly under a lens, the surface of the tongue is seen to be thickly covered with minute pointed filiform papillae, which become larger and flattened with appressed and backwardly directed points in the region of the circumvallate papillae. There is a slight median groove at the tip of the tongue.

The epiglottis is short and cartilaginous, with a prominent median process anteriorly.

The salivary glands (Plate 5, fig. 1, *p*, *s*) are large and prominent. The parotid is the most conspicuous and lies behind the masseter muscle and the ear, with a forward prolongation nearly to the orbit in one specimen examined. Its duct is with difficulty traced from a point below the ear, forward parallel to the roof of the mouth to about opposite the first molar. The submaxillary gland consists of two portions as in Gymnura, one slightly more median, posterior to the angle of the jaw. Both are oval, smaller than the parotid, and slightly darker in color. In Centetes, this gland is in three divisions. Wharton's duct may be traced from the deeper portion of the gland near its center, forward, along the inner side of the ramus to the root of the tongue.

The digestive tract itself is very simple. The walls of the oesophagus, as it enters the stomach, are thrown into about eight longitudinal corrugations that become confluent in part with the more numerous rugae of the lining of the stomach. These latter consist of about 16 deep ridges and more numerous shallow ones, running longitudinally. They become reduced to five or six thickened folds at the pylorus, where they end.

The stomach (Plate 9, fig. 7) in its undistended condition, is subglobular and somewhat produced at the pyloric end as in Gymnura, though not to the extent figured by Dobson for Erinaceus. The cardiac portion shows no such extension as in *Erinaceus europeus*. Peters has figured the stomach of *Solenodon cubanus* as a nearly globular organ with the pylorus very near the oesophagus. This is somewhat different from its appearance in *S. paradoxus* when undistended, and may not represent its true form. The greatest length of the stomach is about 37 mm., and the cardiac breadth about 25 mm.

The small intestine merges with the large intestine so gradually that it is not possible to tell definitely where the two meet, but the thicker-walled portion following the last of the Peyer's patches is here taken to be the large intestine. The total length of the intestine from the pylorus is about 1390 mm., or nearly four and one half times the length from the tip of the nose to the anus. In Gymnura it is about six times the length of head and body. The total length of the small intestine, from the pylorus to the last Peyer's patch is 1200 mm., and the large intestine 190 mm. There is no indication of a caecum. The wall of the small intestine is seen under a lens to be thickly covered with villi which are arranged in more or less transverse zig-zag lines. There are some seven Peyer's patches. The first is oval, about 8 by 5 mm., and situated 132 mm. from the pylorus. At about 185 mm. after this are two smaller patches, one behind the other. A fourth about 14 by 8 mm., is found some 205 mm. posteriorly; a fifth after 250 mm. more, and a sixth, 11 by 5 mm. after 220 mm. The seventh and last is a large one about 1200 mm. from the pylorus.

The course of the intestine from the pylorus is back along the right body wall for about 50 mm., then across to the left side, and thence again posteriorly for some 25 mm., after which it turns ventrally and becomes much convoluted in the lower abdominal region. It then passes forward along the left side of the body and is again much convoluted below the stomach, whence the large intestine, after a short curve ("transverse colon") runs directly back along the dorsal body wall to the anus.

The structure of the liver (Plate 9, figs. 3, 10) is comparatively simple. The

organ is large and composed of three main lobes whose appearance is essentially like that in Centetes. The left lateral lobe is large and rather oval, slightly less in breadth posteriorly than anteriorly. It is without secondary divisions. The right lateral lobe is of smaller diameter and subcylindrical, consisting of two portions: the main lobe proper and the caudate division. The latter is large and of practically equal length with the main lobe into whose dorsal surface it is received by a deep groove. The sides of this groove enfold the caudate lobe so that its exterior surface is continuous with that of the rounded main lobe. The distal ends of the two appressed lobes are hollowed to receive the anterior end of the right kidney, which they thus together surround. In Gymnura the caudate lobe is represented as long and narrow, and alone enfolding the end of the kidney. In Erinaceus the condition is much the same. The Spigelian lobe is very short and single, thus resembling that of Centetes, rather than that of the Erinaceidae in which it is generally larger in proportion and bifid. The central lobe of the liver is practically entire except for a slight fissure at its left end, visible in ventral view, but covered dorsally by the gall bladder. The dorsal surface is deeply grooved for the reception of the pyriform gall bladder, which is partially overhung by a projection of the substance of the liver. The suspensory ligament is attached along the median portion of this central lobe for some 18 mm. Posteriorly a small thread-like division of this ligament is given off to the tip of the secondary lobe separated off by the slight fissure previously mentioned at the left side of the main central lobe. The gall bladder is large and pyriform and its duct, about 30 mm. in length, opens into the small intestine in common with that of the pancreas at about a centimeter from the pylorus.

The pancreas (Plate 9, fig. 7) is a large structure with very definite outline, and consists of two main lobes. The one is elongate, about 55 mm. in length by 15 in width, and of a slightly reddish color. The other is subtriangular, and much more solid in consistency, becoming decidedly thickened at the free rounded apex. The duct is confluent with that from the gall bladder at about 6 mm. from the opening into the small intestine. There are no secondary pancreatic ducts. The great size and solidity of the pancreas are noteworthy in *Solenodon paradoxus*. The slight and racemose structure figured for this organ in *S. cubanus* (Peters, '64, Plate 2, fig. 10) is quite different and may be the result of partial decomposition. In its bilobed character and the stoutness of the large triangular portion, the pancreas of *S. paradoxus* seems to bear much resemblance to that of Chrysochloris.

Glands.— The spleen (Plate 9, fig. 5) is a large flattened mass of a dark red

color attached by delicate mesentery to the cardiac curvature of the ventral portion of the stomach. Its left end curves dorsally, slightly enfolding this part of the stomach, and forms a recurved lobe. When removed and spread out there is seen to be a slight constriction forming another terminal lobe at its right end. These lobes are not indicated by Peters in his drawing of the spleen of *S. cubanus* but otherwise the two organs appear similar.

There is a large mesenteric gland (Plate 9, fig. 6) above the rectum, in the dorsal mesentery, about a centimeter posterior to the left kidney. It is 13 mm. long by 6.5 mm. in greatest width, with slightly lobulate border and a posterior notch for the insertion of a vessel. Other smaller glands are present, 2 or 3 mm. long, scattered throughout the great mesentery, particularly in the region of the stomach, where close to the pylorus is a large gland about 5 mm. long.

The thyroid glands (Plate 5, fig. 1, *t*) are remarkably large, situated one on each side of the throat, posterior to the submaxillary glands. They are oval in shape and in one specimen, measured 22 by 9.5 mm., and 18 by 9 mm. respectively.

The thymus (Plate 9, fig. 1, *t*) is a large median glandular mass partially investing the base of the trachea ventrally just anterior to the heart. It consists of two rounded lobes, one on each side, bound together by connective tissue. The greatest median length of the mass is about 11 mm.

In addition to these, there is a glandular mass at the axilla and another just in front of the hip joint. The latter is rather large, and divided into two main masses, about 21 and 15 mm. long respectively, and each about a third as wide as long. These, as stated by Peters, may be lymphatic glands, or possibly scent glands. They were discovered by Poey in fresh specimens of *Solenodon cubanus*. There are no anal glands such as are found in Gymnura.

Fresh specimens show no skin glands. What Dr. J. A. Allen (:08, p. 513, fig. 8) has figured as a "glandular surface of left thigh" is apparently the result of partial maceration of the hair follicles at that region. These are very large and conspicuous and might readily be mistaken for the openings of glands. In fresh specimens, however, there is no trace of such an area, but the entire surface is well haired.

Mesenteries.— The great mesentery suspending the intestine from the dorsal body wall is continuous for practically the entire length of the gut, and shows no special modification. A short narrow mesentery connects the liver and the small intestine and is continuous with a delicate membrane along the lesser curvature of the stomach.

Lungs.— The lungs (Plate 9, fig. 1) of *Solenodon paradoxus* are capacious and the pleural cavity extends back as far as the 15th rib. At this point the diaphragm arises from the body wall and passes obliquely forward on each side, along the ventral edges of the sternal ribs to the base of the xiphisternum. The lobes of the left lung seem a trifle smaller than those of the right. The left lung is divided into three simple lobes of which the anteriormost is the least, the posteriormost the greatest. The right lung has in addition to the three main divisions corresponding to those of the other side, a well developed azygos lobe arising from the base of the large third lobe. The second lobe differs from that of the left side in having a transverse fissure by which it is divided into an anterior and a posterior portion. Peters figures no azygos lobe in the lungs of *S. cubanus*, and the left middle lobe seems to be more elongated transversely. Apparently *S. paradoxus* resembles Centetes in the character of the lung. Erinaceus is remarkable in having a simple, undivided left lung and greatly elongated azygos lobe. In Gymnura and Chrysochloris the left lung is divided into two lobes and the azygos lobe is more like that of *S. paradoxus*, in which a further step has been taken by the development of a third lobe at the anterior end of the left lung. The lungs of Potamogale are described as essentially similar to those of Centetes.

Heart and its vessels.— The ventricles of the heart (Plate 9, fig. 2) form a rounded mass about 25 mm. long. The right auricle is noticeably larger than the left, with thicker walls. The aorta arises as a large trunk from the right side of the heart, and at the point where it curves to the left side, sends off a large branch. This after about 5 mm. divides into two large arteries, the more exterior of which is the right subclavian, the more interior the right carotid. The left carotid arises separately from the main trunk of the aorta close beyond the first large branch. The left subclavian likewise is given off independently just posterior to the last. The aorta then passes posteriorly and is joined on the ental side by the ductus arteriosus. The pulmonary arteries as usual come from the conus arteriosus. The arrangement of the vessels is thus practically the same as in Centetes, Potamogale, Chrysochloris, and Myogale.

Excretory and genital organs.— The kidneys are similar in both sexes. They are large oval bodies in the usual position against the body wall of the lumbar region, that of the right side slightly anterior to that of the left. The ureters are slender tubes leading as usual to the bladder on each side. The adrenal bodies are oval, each about one third the length of the kidney, and closely appressed along its antero-median border from the hilum nearly to the anterior end (Plate 9, fig. 9).

The testes of the male are oval glands about 9 by 6 mm. bound by a short and rather broad ligament 10 mm. long, to the abdominal wall on either side a few millimeters above and anterior to the symphysis pubis. A long filamentous ligament likewise passes from the attached end of each testis to the posterior region of the adrenal body of each side. The testes are somewhat sunken into perineal sacs, but still wholly internal. The spermatic cords pass ventromedially and the vasa deferentia unite at the base of the bladder. The prostrate glands are small, oval, and united medially on the ventral side just caudad of this point, much as in Centetes. No trace of Cowper's glands could be discovered though their presence may have been overlooked. The penis is retractile and is carried forward along the abdominal wall to about 2 cm. from the anus. As stated by Dobson, this is an important difference in comparison with the condition found in the Centetinae and Potamogalinae in which the penis is retractile within the cloaca. The testes, too, in the Centetinae, are found much farther forward.

The ovaries (Plate 9, fig. 8) in the adult female examined are small bodies about 3 mm. in length, dark brown in color. They are mainly suspended by the ovarian ligament, a thick filament extending along the anterior edge of each broad ligament of the uterus. The Fallopian tubes are short and convoluted, and pass at once into the cornua which are each about 15 mm. long. The posterior position of the ovaries is again different from that found in the Centetidae in which they are close to the kidneys. The uterus is very long and narrow measuring about 40 mm. in length. It is suspended by the usual two ligaments: the broad or ligamentum latum from the body wall to the cornua, and the round or ligamentum rotundum, that bounds the posterior free edge of a fold of the broad ligament, between which and the body wall there is thus formed a shallow diverticulum. The round ligament is inserted just caudad to the cornu of each side, and passes to the body wall about midway on the anterior edge of the pubis. The genital organs of the Cuban Solenodon appear to resemble in essential points, those of the San Domingo species.

BRAIN.

The brain of Solenodon has been hitherto unknown. This organ was removed from one of the specimens and though somewhat softened, it showed a number of interesting conditions (Plate 6, figs. 8, 9). Its general outline is much like that of the brain of Centetes as figured by Leche (:07, p. 102), with

almost straight, posteriorly diverging cerebral margins, instead of the outwardly bowed boundaries seen in Erinaceus, and Hemicentetes, or the concave outlines of Chrysochloris. The olfactory lobes are more oval, as in Hemicentetes (Leche, :07, p. 102, fig. 87) and the constriction between them and the cerebral hemispheres is very shallow in comparison with the condition in the Centetidae. The cerebral lobes do not extend back so far, relatively, as in Centetes, for the opticus and post-opticus are visible in dorsal view, as is true also of Erinaceus. There is a single well marked lateral sulcus on each of the hemispheres as in the latter, and in addition an ill defined sulcus dorsal to this, which may have been the result of poor preservation. The cerebrum of Centetes is represented as quite smooth. The cerebellum is longer in proportion than in Centetes, but otherwise much similar with a prominent vermis bounded posteriorly by a deep notch, and with pointed lateral prolongations directed forwards. In median section, directly ventral to the center of the cerebellum, two slight transverse grooves mark off a well defined pyramis and anterior to it a broader pons.

PLEXUSES.

The brachial plexus (Plate 6, figs. 7, 10) in *Solenodon paradoxus* is chiefly made up of trunks from the sixth, seventh, and eighth cervical nerves and the first dorsal nerve. In one individual, a slender filament was present from the base of the fifth cervical nerve passing posteriorly and receiving two minute threads from the sixth cervical nerve. In *Solenodon cubanus* Dobson found the fifth cervical to enter into the plexus as a major element. More or less variation is to be expected in the details of the arrangement of the nerves, but the chief connections were nearly identical in the specimens examined. The sixth nerve passes distally as a single trunk with a large basal branch to the seventh cervical nerve. In one instance this connecting branch had the appearance of a fusion of a basal branch from both nerves, but in the other the dual nature of the connection was less clear. The lateral branch of the sixth nerve appears to correspond with that supplying the subscapular and teres muscles. The seventh cervical, in addition to the short connection with the sixth, and a similar with the eighth, from the latter of which a common trunk passes off, has a more distal bifurcation, the posterior branch of which unites with a large branch from the eighth cervical. The main portion of the eighth unites with the first dorsal nerve to form a single short trunk, which soon gives off a small posterior branch, the internal cutaneous. The plexus in Solenodon is rather

simple and resembles that of Potamogale and Chrysochloris in being composed of the last three cervical and first dorsal nerves, with the partial exception of the one instance mentioned in which a slender thread from the fifth cervical entered the complex. In *Solenodon cubanus* the fifth cervical nerve seems to enter as a major element of the plexus and the same is true in the Centetidae. This fact is of interest in connection with the additional dorsal vertebra in *Solenodon paradoxus* as compared with the more specialized condition in *S. cubanus*.

The lumbo-sacral plexus (Plate 6, figs. 2, 3) of *S. paradoxus* was dissected in three individuals and found to differ from that figured by Dobson for *S. cubanus*. The chief nerves composing the plexus are the second, third, and fourth lumbars, and the first sacral. In Centetes the second sacral in addition enters into the complex, and this was found to be the case in one of the specimens of *Solenodon paradoxus*. The anterior crural and the obturator nerve arise mainly as branches of the second lumbar in two individuals while in a third they are from the third lumbar. In this specimen the great sciatic is nevertheless, mainly from the fourth lumbar as in the two other individuals. Dobson's figure of the lumbar plexus in *S. cubanus* shows the anterior crural and the obturator arising together as in *S. paradoxus*, but from the *fourth* lumbar while the sciatic is composed of trunks from the first two sacrals. It is possible that confusion has arisen in numbering the several trunks, as otherwise the condition in the two species is the same. In *S. paradoxus* all the lumbar nerves virtually enter into the plexus by the first lumbar nerve sending a minute filament posteriorly to unite with the next following nerve as it issues from its foramen.

SUMMARY.

In external and cranial characters, *Solenodon paradoxus* differs very markedly from *S. cubanus* as has been recently pointed out by Dr. J. A. Allen (:08), who has suggested that these differences may be considered of subgeneric value. In view of his careful summary, it is needless to repeat his conclusions here. It may be added, however, that the presence of a white nape spot is a fairly constant character of *S. paradoxus*, instead of an individual variation as seemed to be indicated by the specimens heretofore known. Further, the supposed glandular surface of the thighs is an appearance apparently due to poor preservation. The presence of long coarse hairs in the pelage in addition to the finer ones in *S. paradoxus* may indicate a step toward the spiny condition of certain other Insectivora.

The muscular anatomy of the two species is essentially similar although in case of the Cuban Solenodon, our knowledge is still somewhat imperfect, and rests almost wholly on the account by Dobson. This author fails to describe in *S. cubanus* a stylo-hyoid, though it may be present as in *S. paradoxus*. Other differences found in the latter as compared with Dobson's description of *S. cubanus* are: a single head to the biceps instead of two; a second head to the gluteus maximus arising from the ilium; slight differences in the insertion of the adductor longus; the union of the soleus with gastrocnemius. Additional peculiarities are the insertion of tibialis anticus upon the entocuneiform instead of on the first metatarsal; the insertion of peroneus longus upon metatarsals 1 and 5; the insertion of tibialis posticus upon the os calcis instead of upon the naviculare as in *S. cubanus* and other allied genera.

Osteological differences beyond those emphasized by previous writers who have compared the skulls only, are: 16 instead of 15 dorsal vertebrae and thus an additional rib in *S. paradoxus*; one less segment to the sternum and a differently shaped xiphisternum; the separation of the radiale and the intermedium, which are said by Dobson to be fused in *S. cubanus*; the distal fusion of the tibia and fibula, described as separate in *S. cubanus*. The proximal expansion of the entocuneiforme to articulate ventrally with the anterior end of the os calcis is also a peculiarity not previously noted, though it may be similarly developed in the Cuban animal. The number of sacrals is probably the same in both species, since the fifth sacral figured by Peters for the latter, seems to be a fused caudal.

Other differences are noted in the visceral anatomy, such as the number of palatal rugae, which are normally eight in number, whereas nine are figured by Peters for *S. cubanus*; the presence of a rounded azygos lobe to the right lung is not noted by Peters, and his figures of the stomach and pancreas show slight differences that may be in part due to poor preservation. The Cuban Solenodon appears further to differ from *S. paradoxus* in that the fifth cervical nerve enters as a major element into the brachial plexus. The plexuses, however, are subject to some slight variation, and additional specimens might show that this is not a constant difference.

Among the less specialized Insectivora, characterized by tritubercular molars, the two species of Solenodon possess characters that abundantly warrant their separation as a family, as has been emphasized by previous writers. Undoubtedly their position is near the Centetidae, from which they differ in a number of specialized characters, as the position of the penis, the differentiation

of the teeth, the development of the snout, the ankylosis of tibia and fibula (at least in *S. paradoxus*). On the other hand Solenodon possesses many generalized characters in common with Centetes, Potamogale, Gymnura, and even Myogale, the two latter of which are the most generalized members of their respective families. Leche (:07) is doubtless correct in making Potamogale the representative of a subfamily (Potamogalinae) of Centetidae, since the loss of clavicles and certain other peculiarities usually emphasized as distinctive, are probably the result of adaptation to an aquatic existence, while the general simplicity of structure and the common anal and genital opening certainly ally it closely to the Centetinae. On the other hand, Potamogale bears considerable superficial resemblance to Solenodon and Myogale in the form of the skull and teeth, and it seems probable that all three represent divergent lines of descent from some common stock.

LITERATURE.

Allen, J. A.

:08. Notes on *Solenodon paradoxus* Brandt. Bull. Amer. mus. nat. hist., 1908, **24**, p. 505–517, pls. 28–33.

Brandt, J. F.

'33. De Solenodonte, novo mammalium insectivorum genere. Mém. Acad. imp. sci. St. Pétersbourg, 1833, ser. 6, **2**, p. 459–478, pls. 1, 2. Also separate, p. 1–20, pls. 1, 2.

Dobson, G. E.

'82–'90. A monograph of the Insectivora, systematic and anatomical. London, 1882–1890, 4to, iv+172 pp., 28 pls.

Gregory, W. K.

:10. The orders of mammals. Bull. Amer. mus. nat. hist., 1910, **27**, p. 1–524.

Leche, W.

:02. Zur entwicklungsgeschichte des zahnsystems der säugethiere, zugleich ein beitrag zur stammesgeschichte dieser thiergruppe. Zweiter theil: Phylogenie. Erstes heft: Die familie der Erinaceidae. Zoologica, 1902, part 37, 104 pp., 4 pls., 59 text-figs.

:07. Zur entwicklungsgeschichte des zahnsystems der säugetiére. Zweiter Teil: Phylogenie. Zweites Heft: Die familien der Centetidae, Solenodontidae und Chrysochloridae. Zoologica, 1907, part 49, 158 pp., 4 pls., 108 text-figs.

Parsons, F. G.

'98. The limb myology of *Gymnura rafflesii*. Journ. anat. phys., 1898, **32**, p. 312–324.

Peters, W.

'64. Ueber die säugethier-gattung Solenodon. Abh. Kön. akad. wissensch. Berlin, 1863, 1864, p. 1–22, pls. 1–3.

Poey, F.

'51. Memorias sobre la historia natural de la isla de Cuba (on *Solenodon cubanus*). Habana, 1851, **1**, p. 23–41, pl. 1.

Verrill, A. H.

:07. Notes on the habits and external characters of the Solenodon of San Domingo (*Solenodon paradoxus*). Amer. journ. sci., ser. 4, **24**, p. 55–57, 1 fig. Also Ann. mag. nat. hist., 1907, ser. 7, **20**, p. 68–70, pl. 4.

EXPLANATION OF PLATES.

PLATE 1.

Fig. 1.— Young female three days old. $\times 1\frac{1}{5}$.
Fig. 2.— Young female with hairy coat complete. About $\frac{2}{3}$ natural size.

J. Nelson del. B. Meisel, lith.

PLATE 2.

Adult male in the rufous phase. About ½ natural size.

G. Nelson del

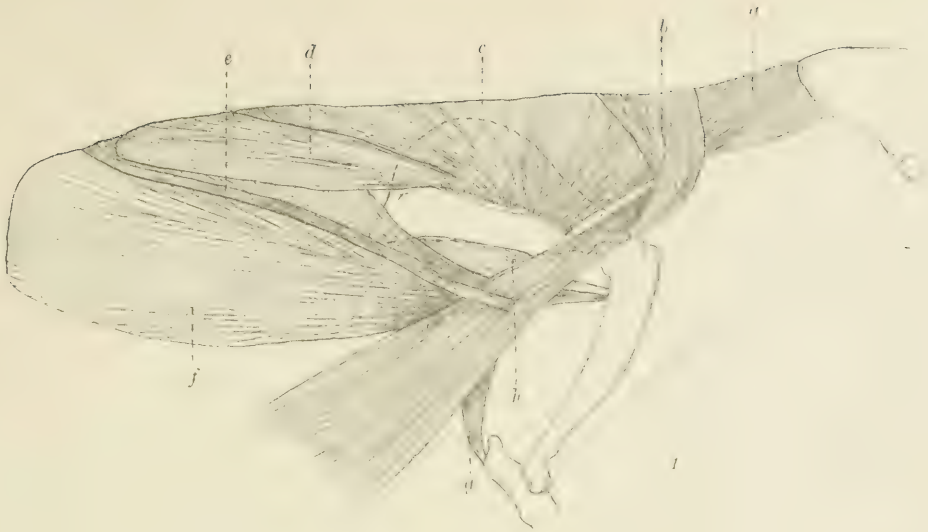
PLATE 3.

Adult female in the pale phase. About § natural size.

PLATE 4.

Fig. 1.— Superficial muscles of the thorax. *a*, clavo-trapezius; *b*, supracervico-cutaneus; *c*, acromio-trapezius; *d*, spino-trapezius; *e*, dorso-cuticularis; *f*, latissimus dorsi; *g*, epitrochlearis; *h*, teres. × 1.

Fig. 2.— Muscles of the hind legs, ventral view. *a*, rectus femoris; *b*, vastus internus; *c*, adductor longus; *d*, semimembranosus; *e*, adductor brevis; *f*, semitendinosus; *g*, gracilis; *h*, quadratus femoris; *i*, flexor longus hallucis; *j*, tibialis posticus; *k*, adductor quartus; *l*, flexor longus digitorum pedis; *m*, adductor magnus; *n*, pectineus; *o*, psoas magnus; *p*, psoas parvus. × 1.


a
b
c
d
e
f
g
1

a
b
c
d
e
f
g
p
o
n
m
l
k
j
i
1
2

PLATE 5.

Fig. 1.— Side view of head muscles. *a*, levator labii superioris et erector vibrissarum; *b*, zygomaticus major; *c*, levator labii superioris proprius; *d*, small muscle corresponding to Dobson's second head of temporalis; *e*, temporalis; *f*, digastric; *g*, masseter; *p*, parotid gland; *s*, submaxillary gland; *t*, thyroid. × 1.

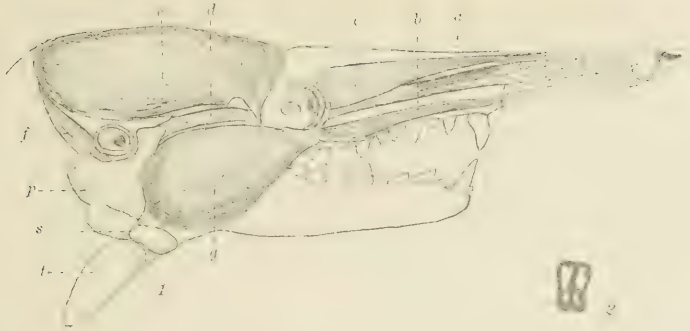
Fig. 2.— Section of cartilaginous proboscis near tip. × 1½.

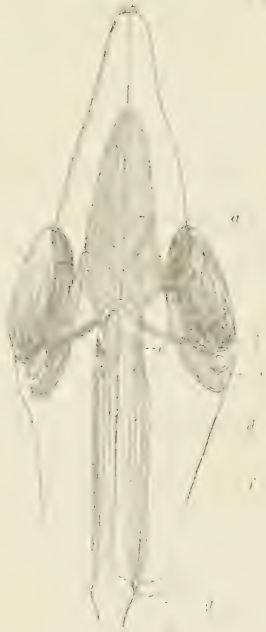
Fig. 3.— Hyoid muscles. *a*, mylo-hyoid; *b*, stylo-hyoid; *c*, digastric; *d*, sterno-thyroid; *e*, crico-thyroid; *f*, sterno-hyoid; *g*, manubrium of the sternum. × 1.

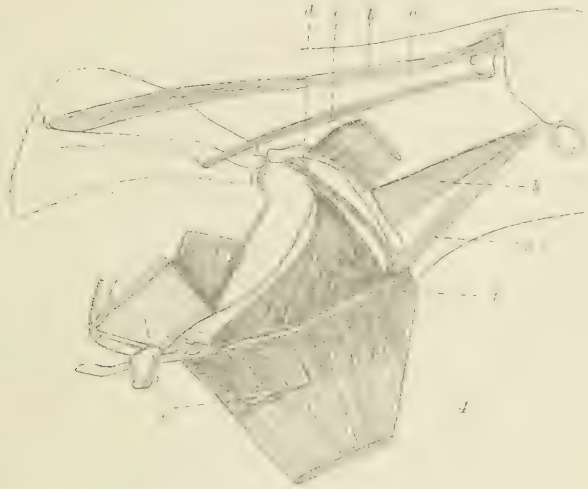
Fig. 4.— Pectoral and cervical muscles. *a*, levator claviculae; *b*, occipito-scapularis; *c*, clavicular portion of ectopectoralis; *d*, subclavius; *e*, ectopectoralis; *f*, entopectoralis; *g*, sterno-mastoideus; *h*, cleido-mastoideus. × 1.

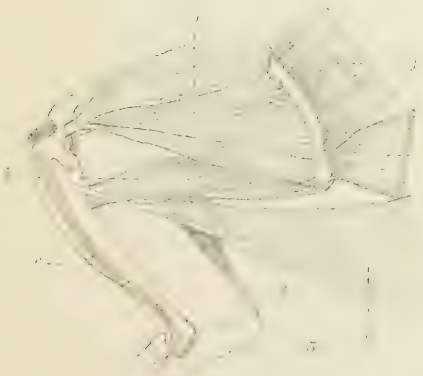
Fig. 5.— Ental aspect of shoulder muscles. *a*, subscapularis; *b*, teres; *c*, coracoideus; *d*, epitrochlearis; *e*, latissimus dorsi; *f*, serratus magnus; *g*, levator anguli scapulae. × 1.

Fig. 6.— Ectal aspect of scapular and forearm muscles. *a*, micostalis; *b*, meditriceps; *c*, ectotriceps; *d*, brevis division of entotriceps; *e*, cephalic division of entotriceps; *f*, combined intermedia and caudalis divisions of entotriceps; *g*, insertion of deltoid muscle; *h*, infraspinatus; *i*, supraspinatus. × 1.









5'4"

PLATE 6.

Fig. 1.— Muscles of right hind leg, ectal aspect. *a*, gluteus minimus; *b*, posterior division of gluteus medius; *c*, gluteus maximus; *d*, semitendinosus, from two heads; *e*, gastrocnemius; *f*, peroneus longus; *g*, extensor longus digitorum; *h*, tibialis anticus; *i*, biceps femoris; *j*, crureus; *k*, vastus externus; *l*, rectus femoris; *m*, second head of gluteus maximus from the ilium; *n*, gluteus medius. × 1.

Figs. 2, 3. Lumbosacral plexuses of two individuals, showing variation. *a*, anterior crural nerve; *o*, obturator; *s*, sciatic. × 1.

Fig. 4.— Ectal view of gastrocnemius showing its two heads and its union with the soleus. *a*, soleus. × 1.

Fig. 5.— Forearm muscles from dorsal aspect. *a*, extensor digitorum communis; *b*, extensores radialis longior et brevior; *c*, pronator teres; *d*, extensor ossis metacarpi pollicis; *e*, extensor carpi ulnaris; *f*, indicator; *g*, extensor minimi digiti. × 1.

Fig. 6.— Forearm muscles from ventral aspect. *a*, flexor sublimis digitorum; *b*, flexor carpi radialis; *c*, flexor carpi ulnaris; *d*, flexor profundus digitorum. × 1.

Figs. 7, 10.— Brachial plexuses of two individuals. v–viii, fifth to eighth cervical nerves; i, first dorsal nerve. × about 3.

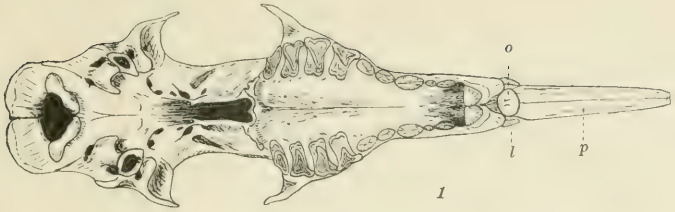
Fig. 8.— Brain, dorsal view. × 1.

Fig. 9.— Brain, sagittal section. × 1.

1
2
3
4
5
6
7
8
9
10
a
b
c
d
e
f
g
h
i
k
l
m
n
o
p
q
r
s
t
u
v
w
x
y
z
IV
V
VI
VII
VIII

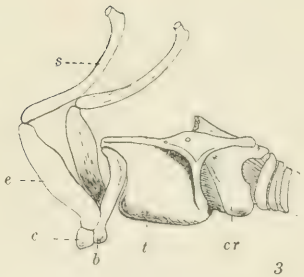
PLATE 7.

Fig. 1.— Skull, ventral aspect. *l*, lateral snout cartilage; *o*, os proboscidis; *p*, cartilaginous proboscis. × 1.
Fig. 2.— Skull, lateral view; lettering as in Fig. 1. × 1.
Fig. 3.— Hyoid apparatus, lateral view. *b*, fused basi- and thyrohyals; *c*, ceratohyal; *cr*, cricoid; *e*, epihyal; *s*, stylohyal; *t*, thyroid. × 2.
Fig. 4.— Atlas, dorsal view. × 1.
Fig. 5.— Atlas, anterior view. × 1.
Fig. 6.— Right ramus, lateral aspect. × 1.
Fig. 7.— Lower left incisors 1 and 2, showing the deep sulcus on the ental face of the latter. × 2.
Fig. 8.— Axis, lateral view. × 1.
Fig. 9.— Axis, anterior view. × 1.
Fig. 10.— Abnormal seventh cervical, with vertebral arch on left side complete. × 1.
Fig. 11.— Sternum, clavicle, and sternal portions of ribs, ventral view. × 1.
Fig. 12.— Dorsal vertebrae, ribs, sternum, clavicle, right lateral aspect. × 1.
Fig. 13.— Lumbar vertebrae, right lateral view. × 1.
Fig. 14.— Lumbar vertebrae, dorsal view. × 1.



1

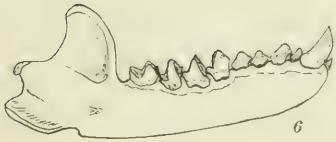
2



3

4

5



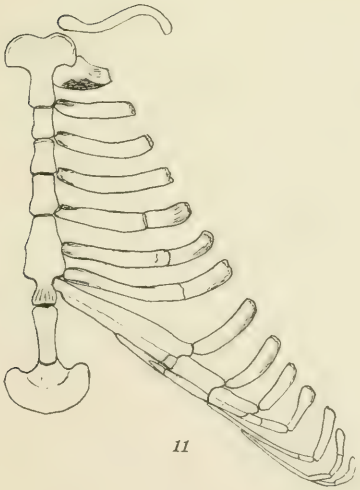
6

7

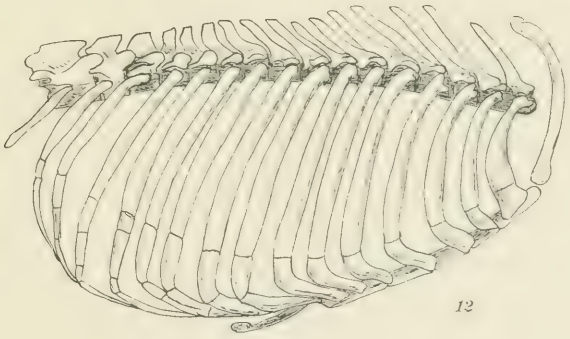
8

9

10

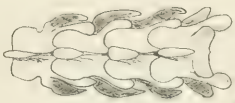


11



12

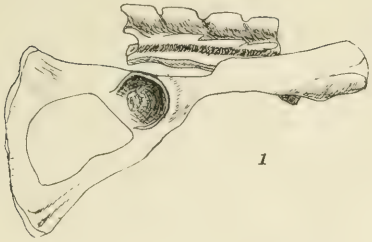
13



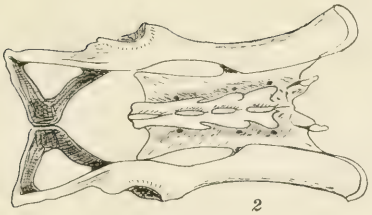
14

PLATE S.

Fig. 1.— Sacral vertebrae and pelvis, right lateral view. × 1.
Fig. 2.— Sacral vertebrae and pelvis, dorsal view. × 1.
Fig. 3.— Six first caudal vertebrae, dorsal view. × 1.
Fig. 4.— Six first caudal vertebrae and chevron bones, ventral view. × 1.
Fig. 5.— Scapula of right side, ectal aspect. × 1.
Fig. 6.— Six first caudal vertebrae and chevron bones, lateral aspect. × 1.
Fig. 7.— Scapula of right side, ental aspect. × 1.
Fig. 8.— Scapula of right side, dorsal view, showing width of mesoscapula. × 1.
Fig. 9.— Humerus of right side, anterior view. × 1.
Fig. 10.— Humerus of right side, posterior view. × 1.
Fig. 11.— Humerus of right side, entolateral view. × 1.
Fig. 12.— Femur of right side, anterior view. × 1.
Fig. 13.— Femur of right side, posterior view. × 1.
Fig. 14.— Fused tibia and fibula of right side, anterior view. × 1.
Fig. 15.— Bones of right forearm, carpus, and manus, ectal aspect. × 1
Fig. 16.— Tarsus and pes of right side, dorsal view. × 1.



1



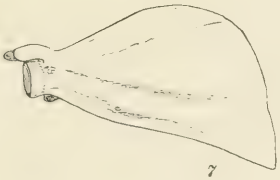
2

3

4

5

8



7

6

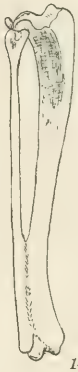
9

10

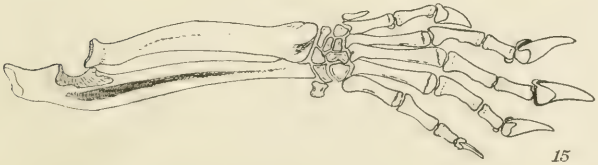
11

12

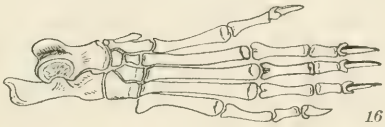
13



14



15



16

PLATE 9.

Fig. 1.— Heart, lungs, trachea, and hyoid apparatus, ventral view. *a*, azygos lobe of right lung; *t*, thymus. × 1.

Fig. 2.— Heart and arterial trunks, ventral view. *c*, right carotid; *c'*, left carotid; *d*, ductus arteriosus; *s*, right subclavian; *s'*, left subclavian; *v*, vena cava. Slightly enlarged.

Fig. 3.— Liver, dorsal view, slightly spread out. *c*, caudate lobe lying in a depression of the right lobe; *g*, gall bladder; *i*, small intestine; *p*, pancreatic duct, cut short above its union with the bile duct; *s*, Spcigelian lobe. × 1.

Fig. 4.— Tongue, dorsal view. × 1.

Fig. 5.— A large spleen, somewhat spread out. × 1.

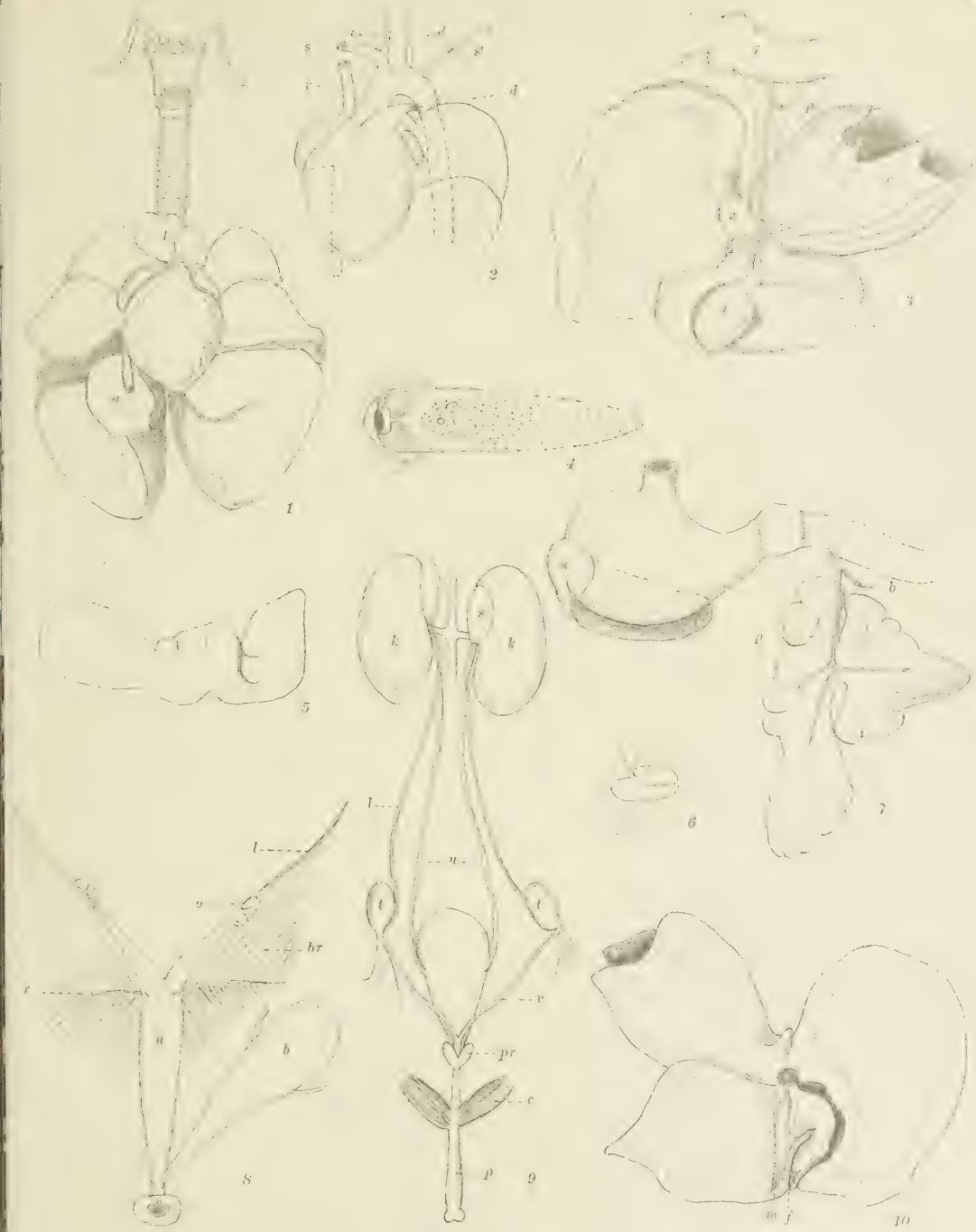
Fig. 6.— Large gland in the mesentery dorsal to rectum. × 1.

Fig. 7.— Stomach and pancreas, dorsal view. *b*, bile duct, cut off above its union with pancreatic duct, *p*; *p*, pancreatic duct; *s*, spleen, partly enfolding cardiac end of stomach. × 1.

Fig. 8.— Female genital organs, ventral view. *b*, urinary bladder; *br*, broad ligament; *l*, ovarian ligament; *o*, ovary; *r*, round ligament; *u*, uterus. × 1.

Fig. 9.— Male genital and excretory organs, ventral view. *c*, crural muscles; *k*, kidney; *l*, ligament; *p*, penis; *pr*, prostate gland; *s*, suprarenal body; *t*, testis; *u*, ureters; *v*, vas deferens. × 1.

Fig. 10.— Liver, ventral aspect, somewhat spread out. *f*, fissure in central lobe; *m*, suspensory ligament. × 1.


1
2
3
4
5
6
7
8
9
10
br
pr

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XL. No. 2.

BREWSTER'S WARBLER.

BY

WALTER FAXON.

With One Plate.

CAMBRIDGE, U. S. A.:
Printed for the Museum.
January, 1911.

BREWSTER'S WARBLER.

THREE years ago, in the Auk for October, 1907, I published an account of a male Brewster's Warbler found during the month of June on the edge of a swamp in the town of Lexington, Mass. Although the bird remained in the same locality throughout the breeding season, neither his mate nor nest was discovered and little hope was entertained that this interesting addition to the Lexingtonian fauna would become firmly established. That such is the case, however, the observations recorded in these pages will tend to show. While I was walking through this same swamp with Dr. W. M. Tyler on the fifth of June of this year (1910), my companion detected a Brewster's Warbler, apparently a female, in some shrubbery in one corner of the swamp, within one hundred and seventy yards of the station occupied by the bird which I discovered in 1907. Close at hand, on the other side of a fence that divides the swamp from a jungle of Gray Birches and Raspberry vines, a male Brewster's Warbler and a male Golden-winged Warbler were chasing each other about amid the low trees and shrubs. Both were singing, one in quick response to the other. The song of each was the familiar song of the Golden-wing, although a difference between the voices of the two birds was discernible, the quality of the tone being sharper and clearer in the Brewster's than in the Golden-wing. The difference however was no greater nor of any other sort than what one perceives in comparing the songs of different individuals of the Golden-wing. In the mutual chase of the two males, the Golden-wing seemed to be the more aggressive.

On returning to the spot where we had left the female, we flushed her from her nest which rested firmly on the ground at the foot of some stalks of Meadow Rue and Rugose Goldenrod, and contained five eggs — white speckled with black or dark brown around the larger pole, and indistinguishable from the eggs of the Golden-wing. The nest, too, was fashioned like the Golden-wing's, being built of dry leaves and Grapevine bark, lined with fibrous shreds of plants and with

White Pine needles. The outside diameter of the nest was $4\frac{1}{2}$ inches, the inside diameter $2\frac{1}{2}$ inches, height 4 inches, inside depth $2\frac{1}{2}$ inches.[1]

The male Brewster's Warbler was one of the pure type, with clear gray back, brilliant yellow crown and wing-patches, and silk-white under parts without any trace of yellow. The female displayed the normal plumage of the female Brewster's, differing from the male in having the back and hinder part of the crown lightly veiled with olive, the wing-patch paler yellow and distinctly divided into two parts, and the breast lightly suffused with yellow, leaving the chin and throat clearly white.

The male Golden-wing that was associated with these Brewster's Warblers was a bird of extraordinary brilliancy and purity of plumage, the white color of the lower breast and belly being less obscured by ash than is the case in many examples, throwing into strong relief the pure black of the throat, the yellow of the wing-coverts and crown and the exquisite blue-gray of the back. The black of the throat extended clear up to the base of the bill, indicating a bird that had attained at least to the second nuptial plumage, if we accept Dr. Dwight's diagnosis.

Two other places on the border of this prolific little swamp were occupied as singing stations by two male Golden-wings, from the time of their arrival on the fifteenth of May. The nest of neither of these was found, nor for that matter were their mates seen until, in the latter part of June, they led their young forth from the nest to feed in the Maple Swamp. From that time onward both of these males, with their mates and young, together with the proprietors of the nest discovered on the fifth of June and their young, were followed up to the time when the family ties were dissolved and the young had acquired the full first-autumn plumage, about the twentieth of July.

The stage upon which the little domestic scenes now to be described were enacted was formed for the most part by the Maple Swamp, a moist area of about 15 acres, grown up chiefly to Red Maples, with a sprinkling of Elms, Red Oaks, and White Pines. The ground beneath, always damp and screened from the parching rays of the sun, is clothed with a rank growth of Cinnamon Fern four to six feet high, interspersed with Spinulose, Boott's, Crested, and Lady Fern, while ample tracts are given over to thickets of Raspberry vines, well-nigh impenetrable. Patches of Jewelweed claim a share of the spongy soil, — spots dear to the Connecticut Warblers in the autumn. Here and there one sees the delicious green of the Clintonia and in a few favored places the eye

[1] This nest is now in the collection of Mr. William Brewster.

fatigued in the pursuit of the elusive little Warblers rests with a sense of relief upon the exquisite tracery of Purdie's Fern.[1]

As July advances, tall stalks of Meadow Rue lift their white plumes to a height of six to ten feet above the ground, while beneath them Canada Lilies swing their golden bells and ring out, to the spirit, "ditties of no tone."

Abutting on one side of the swamp is a tract of long-abandoned tillage land now appropriated by young Gray Birches, with one or two Red Oaks of a much older and larger growth. The areas between the trees form a veritable jungle of Raspberry vines and Poison Dogwood. On another side the swamp is bounded by a grove of Birch with a more recent undergrowth of Raspberry. On the third side one passes by an abrupt transition into an open meadow, the haunt of Meadowlarks and Bobolinks, while the limit of the swamp on the fourth side is fixed by the edge of a woodland of upland Oak cleared of every vestige of undergrowth — the kind of woodland beloved of man but abhorred by most kinds of birds.

To return to the Brewster's Warbler and nest: the sixth and seventh of June were rainy days and the female bird sat so close that I could peer into the nest with my face within a few feet of her without her once abandoning her charge. The male Brewster's spent most of the time singing in a Red Oak in the Birch jungle within forty-five yards of the nest, while the male Golden-wing was never heard to sing from this time onward.

On the morning of the eighth there were five little naked newly-hatched birds in the nest.

On the ninth Messrs. William Brewster and H. A. Purdie accompanied me when I visited the nest; and on that day we got the first inkling of the marital relations of the birds under observation: the male Golden-wing was seen feeding the female Brewster's Warbler in the shrubbery near the nest. After this day he was constant in supplying food to the female or the young, while the male Brewster's spent most of the time singing in his favorite tree and was never seen to feed anything but himself. He would, it is true, make occasional visits to the immediate neighborhood of the nest, particularly if any commotion was excited there by the presence of a squirrel or other unwelcome intruder. On such occasions he showed as much concern as if he had a personal interest in the nest; but every field observer will recognize that this alone is no evidence of proprietorship in the nest. It is a matter of every day observation that birds

[1] *Aspidium concordianum*, a delicate, finely-cut form of *A. spinulosum*, discovered by Mr. H. A. Purdie in the neighboring town of Concord.

of all kinds, even of the most remote relationship, will evince this sympathy with their neighbors in affliction. As an instance to the point: one day in this very place Dr. Tyler caught a young fledgling Veery in his hat: in an instant the cries of the young bird gathered around us every feathered inhabitant of the swamp.

On two occasions the male Brewster's Warbler, in the absence of the male Golden-wing, was seen to engage in what seemed to us a vicious pursuit of the female, only to meet with a repulse.

When highly excited by the intrusion of a squirrel or any other marauder, both sexes of the *Helminthophilae*,[1] but more especially the female, emit a series of peculiar scolding burry notes which suggest the song of the Short-billed Marsh Wren.

By the fourteenth of June the scanty clothing of the nestlings in the shape of scattered patches of gray down was reinforced by the incipient feathers of the so-called first or juvenile plumage. These (on the back) were of an obscure olive-gray, but on the wings the future transverse bars of the median and greater wing-coverts were apparent as yellowish pin feathers. The throats were still bare, the skin thereof being of a reddish-brown hue. On the following day (June 15) the feathers of the throat were just visible, of an olive- or yellowish-gray color.

On the morning of the seventeenth of June the young were all out of the nest, clinging to the low shrubs and Cinnamon Ferns near the nest, a foot or two above the ground. They are now olive-colored on the crown, olivaceous gray on the back; the wings are marked by two transverse widely separated yellowish bars; the under parts are ash-colored tinged with yellow; there are no throat or cheek patches, or clear traces of a trans-ocular streak; the tail feathers, just beginning to sprout, are olive-gray, or olive-slate, like the primary quills of the wings. In appearance and habit they were grotesque little fellows,

[1] Mr. Oberholser (Smithsonian Misc. Coll., Quarterly Issue, May 13, 1905, **48**, p. 66) holds that the name *Vermivora* must supplant *Helminthophila* Ridgway (1882). The genus *Vermivora* was established by Swainson in an essay published in the Zoological Journal, April–July, 1827, **3**, p. 170. The genus was there diagnosed and its type species, *Sylvia vermivora*, explicitly designated as well as implied by tautonomy. In a later-written paper (Philos. Mag., June, 1827, **1**, p. 434), dealing exclusively with a collection of birds discovered in Mexico by the Bullocks, Swainson assigned *Sylvia solitaria* Wils. (= *S. pinus* Linn.), which he thought to be congeneric with *S. vermivora*, to the genus *Vermivora*, referring back to his earlier paper in the Zoological Journal for the foundation of the genus. In the later-written paper *S. pinus* appears as the only species in the genus *Vermivora* merely because it was the only species of the group represented in the Bullock collection.

Swainson's second paper seems to have been published by chance before the first paper, and therefore Mr. Oberholser maintains that *S. pinus* must be taken as the type of the genus *Vermivora*. Thus is plain fact perverted and the careful work of an ornithologist defeated in order to save the countenance of an absurd priority rule-of-thumb. If the genus *Vermivora* be accepted with Mr. Oberholser's connotation, it surely cannot be ascribed to Swainson, but rather to Swainson's editors! If Codes of Nomenclature make no provision for a peculiar case like this, so much the worse for the Codes.

clinging with their disproportionately long legs to the low herbage, like peeping Hylas in the springtime clinging to the grasses and weeds above the surface of the water. The little thread-like natal plumes still waving from the tips of their crown feathers enhanced the oddity of their appearance. Up to this time they were absolutely silent.

By the twentieth of June the young birds had become more active and volatile and had retired by short flights into the swamp to a distance of some forty yards from the nest. Their plumage is now firmer and more compact, the tail feathers about one quarter of an inch in length, the colors essentially the same as described on the seventeenth. Their whereabouts is now often revealed by their peculiar little call for food — a chirp resembling in no remote degree the sound of black crickets.

On the twenty-fourth of June the tails of the fledglings had reached a length of about one inch and displayed conspicuously in flight the white portions of the inner webs of the three outer pairs of feathers. Up to this time the young birds lived exclusively among the Cinnamon Ferns and Raspberry vines, on the ground or within from two to four feet of it. They were exceedingly elusive creatures, making short flights from one dense cover to another. The whole family life was essentially terrestrial. The parent birds, *i. e.* the male *chrysoptera* and the female *leucobronchialis*, would now and then fly up into the trees for food (which consisted largely of a light green larva one half or three quarters of an inch long) but they would soon return to the young in the chief source of the food supply, the shrubbery below. Owing to the young birds' habit of self-concealment it was impossible to determine with precision how many members of this family escaped the perils of infancy, but I feel very sure that three, and probably four, grew to maturity.

Until now (June 24) the male *leucobronchialis* continued to sing, for the most part from his chosen station in the Birch jungle. If by chance the brood of young birds with their parents came into the edge of the jungle, or near it, he was very likely to be found near them; but if they moved into the deeper recesses of the swamp he never followed them, whereas the whole life of the male *chrysoptera* now consisted in supplying the young mouths with food. By June 30 the male *leucobronchialis* was undergoing his moult and had lost most of his tail feathers. On July 3 all the old feathers of the tail had been cast. On July 10 the growth of the new tail was well advanced, while the moult of the body feathers was still going on. After this he was seldom or never seen and the inference is inevitable that he passed the season without a mate. His pro-

tracted period of song, early moult, and probable early migration would be the natural concomitants of celibacy.

On the 26th of June we found the second of the three male Golden-wings feeding a brood of young in the Birch wood on one side of the swamp. This male also, to our astonishment, had taken a Brewster's Warbler for a mate! He could be readily distinguished at a glance from the first one by his duller plumage, the white of the lower breast and belly being more heavily tinged with ash. The young birds of this family were distinctly younger than the other brood — by as much as three or four days, I should think. They were also more numerous — five or six, apparently — and revealed more differences in color than those that had been previously studied. The variations were especially obvious in the wing-bars which in some members of this family were of a much paler yellow (almost white) than in others. On this day the young were for the first time seen to make occasional flights into the lower branches of the tall trees. On the 29th we observed that one of the little birds of this brood (and so far as we could perceive, only one) had a triangular dusky area on the throat and a similarly colored patch on each cheek, in short was a young *chrysoptera*.

A few days later the scope of our field study was enlarged by the discovery of the whole family belonging to the third male Golden-wing that has been already mentioned as occupying a station on the edge of the swamp in the early summer. His mate proved to be a normal female Golden-wing and all the young were Golden-wings, with dusky throats and cheeks.

For the moment we were a little staggered as we thought of the complications that might arise from the presence of three broods within a comparatively limited area; but we were delivered from confusion by one feature in the life history of these birds: the integrity of the several families was absolutely maintained as long as the young were fed by their parents, and this condition endured up to about the twentieth of July.

The manner of making observations on these birds was as follows: On first entering the precincts of the swamp I would listen intently for the voices of the young birds. Their cricket-like chirping was incessant throughout the long period in which they were fed by the old birds and fortunately their notes were very characteristic and distinctive. The only sound in the swamp that could be mistaken for the voices of the hungry little *Helminthophilae* was that emitted by a young Cow-bird being fed by its foster-parents, a pair of Chestnut-sided Warblers. The chirp of the young *Helminthophilae* also resembled in no

remote degree the cries of young Chipping Sparrows at a certain stage in their career. But there were none of these birds in the swamp to confuse one.

With this clue to the whereabouts of one of the families sought, a cautious approach would reveal one or both of the parent birds in their continual and indefatigable pursuit of food for the chirruping young. The source of the food-supply was to some extent the foliage of the tall trees overhead, but chiefly the undergrowth of ferns and Raspberry vines. At first the life of the young birds was passed exclusively in the dense herbage and shrubbery near the ground, but by the twenty-sixth of June they had acquired strength and confidence enough to make occasional sallies into the trees, soon to return to their favorite haunt on the ground below. Here they would take frequent short flights of two or three rods, from cover to cover, displaying in their course the obvious white markings of the tail feathers. By standing perfectly still, sometimes on the vantage ground of a small hillock or stump, I would from time to time get a good view of one or another of the brood. When Dr. Tyler was with me, we would sometimes adopt the following method of getting a close observation of the young birds: one of us would sit upon the ground, completely hidden in the Cinnamon Ferns, while the other would slowly drive the little birds toward the place of concealment. By this *ruse* we now and then succeeded in getting observations at a marvellously short range, so short, indeed, that I had to discard my field-glasses and put on my reading-glasses.

On the approach of the parent bird with food, the youngling would receive it with accelerated chirps and quivering wings. In the intervals between the visits of the parents the young would condescend to a little listless gleaning of food for themselves, at least after they were a few weeks old, but this did not seem to moderate in the least degree their demands upon their parents.

During some of our visits to the swamp we had all three of the families under observation within the space of two or three hours. As has been already pointed out, keys for the identification of the different families were furnished both by the adult and the young birds. In the group to which the nest belonged the father, a *chrysoptera*, was so much brighter in color than the father of the second family that he could be recognized at a glance; the young, moreover, were older and ever in a more advanced state of plumage. The third family was identifiable by the mother's being a *chrysoptera* and the young ones also *chrysopteras*, with dusky throats and ear-coverts, whereas both the other broods had *leucobronchialis* mothers and, with the exception of one individual of the second family, lacked the diagnostic markings of *chrysoptera*.

If perchance two of these families met together in their movements to and fro through the swamp (we saw this happen only twice during our long watches) a momentary confusion would ensue, but this would be quickly dispelled by the segregation of the different family groups.

The range of these birds extended occasionally into the Gray Birch growth that abutted on two sides of the swamp. It was interesting to find that the open oak wood on the south, barren of any undergrowth, proved to be a barrier to their progress in that direction as effectual as the Bobolink meadow on the east.

A similar mode of life while rearing their young was followed by the numerous Veeries, Chestnut-sided Warblers, Oven-birds, Maryland Yellowthroats, and Indigo-birds, that inhabited the same swamp. The Black-and-White Warblers and Redstarts, on the contrary, took care of their broods up in the trees.

By the fourth of July the young birds belonging to the oldest brood had acquired in a large degree the first-winter plumage and were approximately as large as their parents. Their color is now gray above, tinged with olive, more especially on the rump and upper tail-coverts. Lores black, but the black color not easily traced behind the eye. Forehead yellow, as in the adult female *leucobronchialis* and *chrysoptera*. Below, dull ash, washed with yellow, including the throat. Wing-bars pale yellow. The breast has a patchy or spotty appearance, evidently caused by the transition from the darker juvenile to the lighter first-winter plumage.

On the tenth of July we saw at least three of the young of this family, when they appeared to be as large as their parents and were hardly distinguishable from them if it were not for the fact that the old birds were still busily engaged in feeding them, and that the characteristic chirruping of the young was still kept up. In fact the plumage of the young was now brighter than their mother's, their polls being more extensively yellow, their lower parts whiter. The wing-bars which were double and widely separated in the juvenile plumage now seemed to be reduced to a single yellow bar.[1]

We have now followed up the brood which issued from the nest on the seventeenth of June to a point where they have essentially acquired the plumage of the adult, and we have seen them develop into pure Brewster's Warblers (*i. e.* in plumage). By keeping them under observation until the completion of the post-juvenal moult it has been demonstrated that they are not only not *chrysopteras* but not even transitional forms in any respect between *chrysoptera* and *leucobronchialis*, but *leucobronchiales* of extraordinary purity.

[1] Probably because one set of coverts had not yet been renewed after the post-juvenal moult.

To return to the second family which we left on the twenty-ninth of June. This brood also, it will be remembered, was of mixed parentage, the father being a *chrysoptera*, the mother a *leucobronchialis*. On the eighth of July the young were well along in their progress to the first-autumn plumage. The one with the dusky throat and ear-coverts now shows the characteristic marks of *H. chrysoptera*, the dark ash, or slate-colored throat and upper breast being sharply defined against the ashy-white lower breast and sub-malar stripes which meet together on the chin. The dark areas on the sides of the head are likewise well defined. The crown is still olive-colored, the back gray, with a touch of olive. The other members of this brood of young birds have the under parts gray throughout, tinted with a varying amount of yellow in different individuals. This variability may be connected with sex, the female *leucobronchialis* being more distinctly charged with yellow than the male. No member of this brood, with the exception of the one above noted, showed any trace of the *chrysoptera* throat and cheek markings.

On the fourteenth of July I shot one of the young Brewster's Warblers belonging to this brood. The length of this specimen [1] in the flesh, from the tip of the bill to the end of the tail, was 4.8 inches, wing 2.5 inches, tail 1.9 inches. Forehead and crown yellow, veiled posteriorly by the olive-green tips of the feathers; narrow supra-ocular line whitish; the rest of the upper parts gray tinged with olive; lores and a post-ocular spot black; rectrices slate-colored, the inner webs of the external pair extensively, of the second and third pairs entirely, white;[2] primaries slate-colored, edged with gray; secondaries slate-colored, edged with olive; median and greater wing-coverts tipped with yellow; these coverts have not yet completed their growth after the post-juvenal moult, many of them still being in the shape of sprouting pin feathers; under parts white, lightly washed with yellow, especially on the breast, and with a faint tinge of ash on the flanks. Dr. H. W. Rand, who kindly sexed this specimen for me, reports it to be a male.

By the seventeenth of July the young of this brood appeared to have assumed their full winter dress. The young *chrysoptera* differed from his father merely in having the yellow of the crown and gray of the back washed over with olive, and the sub-malar white stripes of the right and left sides united on

[1] Fig. 1 on the accompanying plate. Coll. Mus. Comp. Zoöl., No. 48385.

[2] Mr. C. J. Maynard (Warblers of New England, 1904, p. 85–85) sets great store by the caudal color-patterns in *Helminthophila pinus*, *H. chrysoptera*, and the closely related forms *H. leucobronchialis* and *H. lawrencei*. I do not believe that the tail markings in these birds signify anything beyond a large range of individual variation.

the chin. All the rest of this brood, like the one shot on the 14th, were *leucobronchiales*.

At this date (July 17) the young birds, though still receiving food from their parents, feed themselves freely, both in the trees and in the underbrush, where we sometimes observed them basking with outstretched wing in a spot of sunlight. They are now more silent than before and their peculiar infantile chirp has become distinctly transformed into a note resembling the chirp of the adult bird.

It now remains briefly to consider the third family of *Helminthophilae*. The parents in this case were both normal Golden-wings and all of their young, so far as we could discover, were also Golden-wings. Observations taken on the seventeenth of July disclosed the young in their autumnal dress. One at least was a female, with the throat and sides of the head of a very light gray color, but clearly marked off by the much whiter hue of the breast, submalar and supra-ocular stripes. The majority of the young were males, now similar to the adult male in plumage, but more olivaceous on the back; the black throat and cheeks slightly veiled by a yellowish wash; the sub-malar stripes, too, met each other broadly under the bill, while in the adult male, as was the case in the other two families, the chin was black throughout. At such close range were some of these birds observed (July 18) that I could see through opera-glasses the sprouting feathers of the wing-coverts as plainly as if the bird were in my hand.

About the twentieth of July the bonds which held these little families together were broken. The change was startlingly abrupt. In passing through the swamp we were no longer greeted by the chirrupings of the little birds. From time to time we might detect a *chrysoptera* or a *leucobronchialis* or two, perhaps in company with some other kind of warbler, feeding silently, well up in the tree-tops, but in most cases it was impossible to decide whether it was an old or a young bird. On two occasions, on the 18th and 20th of July, I heard a *chrysoptera* sing three or four times in succession the longer second song of this species; this was the only singing of these birds noted since the *chrysoptera* stopped singing on the sixth of June and the *leucobronchialis* on the twenty-fourth. The Brewster's Warblers were seen for the last time on August 7; one or two Golden-wings were seen on August 8, and a single male on August 21.

In order to form a judgment concerning the probability of some of the conclusions arrived at in the foregoing pages the reader should be aware of the amount of time spent in making the observations. From the time the young

birds of the earliest brood left the nest, June 17, to the 20th of July when the opportunities for observing were lost on account of the dispersal of the families is a period of 34 days. I devoted a portion of twenty-four of these, amounting altogether to upwards of 75 hours, to the study of these birds. If now it be borne in mind that for a month or more after leaving the nest the young are constantly fed by the parents and most assiduously by the male, the inference that the male *leucobronchialis* was unmated is irresistible. That there was but one *chrysoptera* in the second brood observed is not so certain, but probable in the highest degree. At all events a large majority of this brood were *leucobronchiales*.

Since *Helminthophila leucobronchialis* was first described by Mr. Brewster in 1874, almost every conceivable hypothesis has been advanced by one writer or another to fix its true status in our bird-fauna. And yet it remains one of the most perplexing of ornithological problems. It was at first treated as a valid species, but its rarity, its association with *H. pinus* or *H. chrysoptera*, its intergradation with one or the other of these species, especially the former, by a series of intermediate forms, the peculiarity of its distribution, and the fact that it possesses no peculiar characters which are not found in either one or the other of the two species mentioned,[1] led soon and inevitably to the theory that it is nothing else than a hybrid produced by the union of *H. pinus* and *H. chrysoptera*. Mr. Brewster himself was one of the earliest advocates of this theory and he has consistently adhered to it up to the present time. In the Bulletin of the Nuttall Ornithological Club, 1881, **6**, p. 218–225, he gave his reasons for thinking that *H. leucobronchialis* and *H. lawrencei* both were hybrids of *H. pinus* and *H. chrysoptera*, the two forms being produced by a reversal of the sexes in crossing, like the mule and the hinny.

In the Auk, 1885, **2**, p. 359–363, Mr. Ridgway while admitting *lawrencei* to be a hybrid between *pinus* and *chrysoptera* held to the view that *leucobronchialis* was a distinct species, which by interbreeding with *pinus* produced the various intermediate stages connecting *leucobronchialis* with *pinus*, and by interbreeding with *chrysoptera* produced the extremely rare forms which combine characters of *leucobronchialis* and *chrysoptera*. A few years later (Manual N. A. Birds, 1887, p. 486), Mr. Ridgway deemed it more likely that *leuco-*

[1] Mr. Ridgway, Dr. Bishop, and Mr. Chapman have maintained that the white throat of Brewster's Warbler is a peculiar character not found in either the Blue-winged or the Golden-winged Warbler. Although this is technically true it does not seem to me to bear against the theory that Brewster's is a hybrid between the Blue-winged and the Golden-winged Warblers. If the Golden-wing transmitted the white ground color of the lower parts without transmitting the black throat one would expect the hybrid to have a white throat.

bronchialis and *lawrencei* were dichromatic phases — the former a leucochroic or white phase of *pinus*, the latter a xanthochroic or yellow phase of *chrysoptera*.

Dr. Bishop in the Auk, 1905, **22**, p. 21–24 adopts Ridgway's theory that *leucobronchialis* is a white color-phase of *pinus* but sticks to the older belief that *lawrencei* is a hybrid.

The old notion that *leucobronchialis* is a true species has been pretty generally abandoned although it is still held by Messrs. C. J. Maynard and W. E. D. Scott. Mr. Maynard (Birds of Eastern North America, Revised Edition, 1896, p. 577–578, Warblers of New England, 1904, p. 83 88) believes that Brewster's and Lawrence's Warblers are both species of very recent origin, which have arisen as offshoots from *H. chrysoptera*. The late Mr. Scott on the other hand (*Science*, 1905, **22**, p. 273–281) thought that the two lately-evolved species had originated as mutants from *H. pinus*.

Finally, Dr. C. W. Townsend, in the Auk, 1908, **25**, p. 65–68, as an alternative to the theory of the hybrid origin of Brewster's Warbler, suggests the possibility of its being an atavistic phase of the Golden-wing which may perhaps in some cases develop a black throat in the second-winter plumage, like a Redstart (*Setophaga ruticilla*).

I do not see that there is anything left for a new aspirant to honors in guessing unless it be the conjecture that *Helminthophila pinus* and *Helminthophila chrysoptera* are themselves nothing but southern and northern dichromatic forms of one and the same species!

The published observations that have any bearing on the status of Brewster's and Lawrence's Warblers fall naturally into two categories: first, direct observations indicating the nuptial alliances of either Brewster's or Lawrence's Warblers, or of the Blue-winged with the Golden-winged Warbler; second, observations of young birds one of whose parents alone was seen but whose plumage nevertheless betokened a mixed parentage. To the first category belong the following:

1. Chapman, Auk, 1887, **4**, p. 348. Englewood, N. J. *Leucobronchialis* ♀, shot, June 26, 1887. At the same time and place a *pinus* ♂ feeds four young, three of which were shot and proved to be *pinus*. [These young are well along in their autumn plumage and are certainly *pinus*. The *leucobronchialis* was of course probably their mother.]
2. Eames, Auk, 1888, **5**, p. 427. Seymour, Conn. *Leucobronchialis* ♂ and *pinus* (♀?) associated together, June 3 et seqq., 1888, the only *Helminthophilae* seen in the locality.

3. Sage, Auk, 1889, **6**, p. 279. Portland, Conn., June 13, 1889. *Pinus* ♂ and *chrysoptera* ♀ engaged in visiting a nest and feeding five young in juvenile plumage. These were all collected. [They will be described further on.]
4. Eames, Auk, 1889, **6**, p. 307. So. Conn. *Leucobronchialis* ♂ and *pinus* ♀ feeding young, June 24, 1889. The young looked like *pinus*.
5. Chapman, Auk, 1892, **9**, p. 302. Englewood, N. J. *Leucobronchialis* ♀, washed with yellow below, wing-bars white [*i. e.* an intermediate between *leucobronchialis* and *pinus*] flushed from nest and joined by a typical *pinus* ♂, who shared her anxiety. June 12, 1892. Nest afterward deserted.
6. Eames, Auk, 1893, **10**, p. 89. Bridgeport, Conn., June, 1892. *Leucobronchialis* ♂ with *pinus* ♀ for a mate [no evidence that they were mates adduced, there was a *lawrencei* ♂ within a stone's throw]. Nest found. Two young hatched in this nest were like the young of *pinus* when they left the nest. [*Leucobronchialis* and *pinus* look very much alike at the time they leave the nest.]
7. A. H. Verrill, Auk, 1893, **10**, p. 305. New Haven, Conn. *Lawrencei* breeding. Six young in nest, June 5, 1893. [Unfortunately no detailed observations are recorded in this case to show clearly whether both parents were *lawrencei*.]
8. Sage, Auk, 1895, **12**, p. 307–308. Portland, Conn., June, 1894. *Leucobronchialis* ♀ [grading toward *pinus*] and *chrysoptera* ♂ (♂ flew to ♀ occasionally), nest, and eggs. Both birds, nest and eggs collected.
9. Bildersee, Bird Lore, 1904, **6**, p. 131–132, Beebe, Auk, 1904, **21**, p. 387–388. Bronx Park, N. Y. *Lawrencei* ♂ mated with *pinus* ♀, nest with six young. [Mr. Beebe says these young in the nest June 13, 1904, were all in the typical nestling plumage of *H. pinus*. Mr. Bildersee describes them with some detail. On the fourteenth of June they showed traces of yellow on the breast, the jugulum and middle of the belly were bare, the wing-bars white. I do not understand why they were identified as *pinus* rather than *lawrencei*.]
10. Bishop, Auk, 1905, **22**, p. 23. New Haven, Conn. *Pinus* ♂ nesting with *chrysoptera* ♀, May 23, 1898 (*teste* A. H. Verrill). [No details.]
11. Bishop, Auk, 1905, **22**, p. 24. *Pinus* ♂ mated with ♀ intermediate between *chrysoptera* and *lawrencei* (*teste* A. H. Verrill). May 21, 1902. [No details.]

12. Meeker, Auk, 1906, **23**, p. 104. Bethel, Conn., June, 1906. *Chrysoptera* ♂, *pinus* ♀, nest and five young. [One of them found, June 16, after leaving the nest, appeared to be a typical young *pinus*. A *pinus* ♂ was also present. Neither of the males was seen to feed the young, nor is it stated that either male was seen feeding the female. Proof as to which male was the mate of the female in this interesting case is therefore lacking in the published record. Moreover, *pinus* and *leucobronchialis* look so much alike at the time they leave the nest, that the author's identification of the young bird as *pinus* is of no value unless he is very familiar with *leucobronchialis* in juvenile plumage.]
13. Granger, Auk, 1907, **24**, p. 343, Faxon, Auk, 1907, **24**, p. 444, Maynard, Warblers of N. E., Addenda, 1908, p. 139-140, pl. XIII. Jamaica Plain, Mass., June, 1907. *Leucobronchialis* ♂ mated with *chrysoptera* ♀, nest and young.
14. Maynard, Rec. Walks and Talks, 1908, **1**, p. 79–80, Sherman, Auk, 1910, **27**, p. 444. Jamaica Plain, Mass., June, 1908. *Leucobronchialis* ♂ mated with *chrysoptera* ♀. [Same locality as No. 13.]
15. Peters, The Wren, 1909, **1**, p. 45. Braintree, Mass. *Chrysoptera* ♂ and *leucobronchialis* ♀, nest and young which died in the nest.
16. Bishop, Auk, 1910, **27**, p. 464. Woodmont, Conn. *Lawrencei* ♂ probably mated with *pinus* ♀, nest and four eggs; all were collected; June 4, 1909.

To these sixteen cases are now to be added the two treated of in this paper, both of them being cases of the union of *chrysoptera* ♂ with *leucobronchialis* ♀.

Among observations belonging to the second category, *i. e.*, of young birds one of whose parents alone was seen but whose plumage nevertheless pointed to a mixed parentage I have noted the following:

1. Brewster, Bull. N. O. C., 1881, **6**, p. 220–221. Highland Falls, N. Y., July 7, 1879. *Lawrencei* ♀ with a young one which is clearly a *leucobronchialis*.
2. Fisher, Auk, 1885, **2**, p. 378–379. Sing Sing, N. Y. *Chrysoptera* ♀ feeding young with first-autumn plumage of *pinus*, July 4, 1885, yellow below, wing-bars white [Coll. J. E. Thayer, no. 8775]. Another of the young resembled the mother, no yellow on the breast.
3. Bishop, Auk, 1894, **11**, p. 79–80. New Haven, Conn. *Leucobronchialis* (♀ ?) feeding two young, July 4, apparently *H. pinus*. In one the wing-bars were white, in the other they were broader and light yellow.

4. Voorhees, Auk, 1894, **11**, p. 259–260. *Lawrencei* ♀ feeding first plumage [?] young, July 12, 1893, which appeared to be *pinus*; showed clearly the well defined black lores of *pinus*. [From the date and description, these young were probably in first-autumn plumage.]
5. Dwight, Sequence of Plumages, Ann. N. Y. Acad. Sci., 1900, **13**, p. 246. Englewood, N. J. *Pinus* feeding two young, one of which is *pinus*, the other *lawrencei*, June 28, 1897.

In dealing with the observations pertaining to the first category one is seriously embarrassed in many cases by the insufficiency of the evidence adduced to show that the birds observed were mated. In some cases, indeed, the observer has failed to give any facts whatever to establish the conjugal relation, whatever good evidences he may have had and withheld from publication. This is very regrettable in a matter of so much interest. To one who has perused the foregoing pages it will be clear that the mere association at a certain time of a male and a female is not enough to prove that they are paired. In the lack of a protracted series of observations the evidence of conjugal union obtained by seeing the male feed the female, or the male and female feed the young will be accepted by every one who is familiar with the life of these birds as conclusive, — as conclusive, in my estimation, as the witnessing of *coitus*.

Application of rigid tests will show that probably not more than one half of the eighteen recorded cases, given on page 68–70, are certain. The others must be regarded as probable, some of them, in fact, as merely possible. All of the records may be summarized as follows: —

Pinus × *chrysoptera*. ♂ × ♀, 2; ♀ × ♂, 1; = 3.
Pinus × *lawrencei* + *chrysoptera*. ♂ × ♀, 1.
Pinus × *lawrencei*. ♀ × ♂, 2.
Pinus × *leucobronchialis*. ♂ × ♀, 2; ♀ × ♂, 3; = 5.
Chrysoptera × *leucobronchialis*. ♂ × ♀, 4; ♀ × ♂, 2; = 6.
Lawrencei × *lawrencei* (?), 1.

It appears from the above summary that although eleven cases, more or less well authenticated, of the mating of Brewster's Warbler have been observed, yet in not a single instance has it been found matched with another Brewster's Warbler.[1] The union was always with either a Blue-winged Warbler or with

[1] No particulars concerning the Lawrence's Warbler found breeding near New Haven, Conn., June 5, 1893 (A. H. Verrill, Auk, 1893, **10**, p. 305) are given, so that we are left in the dark as to whether this was a genuine case of a "hybrid" mated with a "hybrid."

a Golden-wing.[1] When one considers the number of Brewster's Warblers that have been found in certain parts of Connecticut, these misalliances can hardly be attributed to accident. They go to make a strong case against the theory that Brewster's Warbler is a valid species. So, too, the state of affairs disclosed in the Lexington swamp, where a beautiful male Brewster's Warbler failed to secure a mate while two female Brewster's Warblers mated with Golden-wings. This bears with equal weight, moreover, against the view that Brewster's Warbler is a color-phase of the Blue-wing, a view that implies the failure of the male to secure a mate although competing with males of another species. Why, furthermore, if *leucobronchialis* be an albinistic form of *pinus* should the white wing-bars of *pinus* be transformed into the yellow wing-bars of *leucobronchialis*?

Dr. Townsend's suggestion that *leucobronchialis* may be a dimorphic form of *chrysoptera* is opposed to the fact that the former is rarely found where the latter is a common bird, but usually where *pinus* is common, and where the distributional areas of *pinus* and *chrysoptera* meet.

To the hypothesis that Brewster's Warbler is a hybrid resulting from the union of the Blue-wing and the Golden-wing I can see no objections. A very large majority of the specimens of Brewster's Warbler that have been discovered have been found in regions like the State of Connecticut where the ranges of the Blue-wing and the Golden-wing overlap. The sporadic appearance of *leucobronchialis* in a region like Eastern Massachusetts is amply accounted for by the occasional occurrence of *pinus* in the same region.

In a suggestive note published in the Auk, 1908, **25**, p. 86, Mr. J. T. Nichols shows that in case of a union of *H. pinus* with *H. chrysoptera*, if we assume that the white ventral color of *chrysoptera* and the plain throat of *pinus* play the part of dominants in transmission, by Mendel's Law of Heredity the offspring, F_1, should all be Brewster's Warblers in plumage. Adopting Mr. Nichols's system of symbols, let W stand for the dominant white under parts of *chrysoptera*, w for the recessive yellow of *pinus*; let P stand for the dominant plain throat of *pinus*, while p represents the recessive black throat of *chrysoptera*. Then:

[1] Mr. C. J. Maynard (Warblers of New England, Addenda, 1908, p. 139–140; Record of Walks and Talks, 1908, **1**, p. 79) and Mrs. J. W. Sherman (Auk, 1910, **27**, p. 444) by some strange vagary have identified the mates of the male Brewster's Warblers that bred in the Arnold Arboretum, Jamaica Plain, Mass., in the summers of 1907 and 1908, as female Brewster's Warblers. They were in reality Golden-winged Warblers in very high plumage, the throat patch being uncommonly dark for the female, and the upper border of the ash-colored cheek patch deepened into a dusky hue. Mrs. Sherman has added to the confusion by publishing in the Auk, 1910, **27**, p. 443–447, an account of a pair of Golden-winged Warblers found breeding in Roslindale, Mass., in June, 1910, which she was deluded into believing to be a male Golden-wing and a female Brewster's Warbler! A female Brewster's Warbler does not have a dusky nor a gray throat patch, neither does it have a gray cheek.

P w (*pinus*) × p W (*chrysoptera*)

F_1 P w p W

That is, the offspring of the first generation will all be impure dominants, but in plumage P W, *leucobronchialis*. If two of these hybrids of the first generation should mate together and produce offspring the second filial generation would comprise Brewster's Warblers, Blue-wings, and Golden-wings, and also the pure recessive, Lawrence's Warbler (pw pw), in the relative numerical proportion of 9, 3, 3, 1. But we have seen that as far as observations show, Brewster's Warbler always breeds back with one of the hypothetical parent forms, *pinus* and *chrysoptera*. In that case the advent of Lawrence's Warbler will be deferred to the third filial generation when it will come to light in small numbers as compared with the dominant hybrid, Brewster's Warbler.

Pw × pW

pW × Pw pW × Pw

	chryso.	= pW pW
	leuco.	= pW Pw
F_2	*leuco.*	= pW PW
	chryso.	= pW pw
		Pw Pw = *pinus*
		Pw pW = *leuco.*
		Pw PW = *leuco.*
		Pw pw = *pinus*

F_2 *leuco.* = pW Pw × pW pw = *chryso.*

	pW pW	= *chryso.*
	pW pw	= *chryso.*
	pW pw	= *chryso.*
	pW pW	= *chryso.*
	Pw pW	= *leuco.*
	Pw pw	= *pinus*
F_3	Pw pw	= *pinus*
	Pw pW	= *leuco.*
	pw pW	= *chryso.*
	pw pw	= *lawrencei*
	pw pw	= *lawrencei*
	pw pW	= *chryso.*
	PW pW	= *leuco.*
	PW pw	= *leuco.*
	PW pw	= *leuco.*
	PW pW	= *leuco.*

That is, if an F_2 pW pw (in plumage a *chrysoptera*) mate with the hybrid pW Pw (*leucobronchialis*) of the same generation, their issue would be, on the average, *chrysoptera*, *leucobronchialis*, *pinus*, and *lawrencei* in the relative proportions of 3:3:1:1. The only other possible unions which could produce Lawrence's Warblers, if the union of two Brewster's Warblers be debarred, are indicated above by the dotted lines, — altogether five combinations out of twenty-two possibilities. It is evident, therefore, that Lawrence's Warbler, by this theory of its origin, must ever be a very much rarer bird than Brewster's Warbler, and that such is really the case is well established by the records. The hybrid theory illumined by the Mendelian Law of Heredity accounts not only for the existence of Brewster's and Lawrence's Warblers but also for the relative abundance of these two extraordinary forms. What more should be required of a working hypothesis?

I regret that the crucial test afforded by the mating of *H. pinus* with *H. chrysoptera* was not presented for study in Lexington last summer. The chances of meeting with a case of this sort here are very remote, *H. pinus* being so rare as almost to be classed as accidental. In place of the union of the two hypothetical parent species I had in both cases to deal with the union of the hypothetical hybrid, *H. leucobronchialis*, with one of the parent species, *H. chrysoptera*. The results were not devoid of interest. As has been shown, the offspring were all like one or the other of the parents, *i. e.* they were either *leucobronchiales* or *chrysopterae*. There were none that showed characters intermediate between the parents. In other words Mendel's Law of Dominance was operative.[1]

By our theory the union of an F_1 *leucobronchialis* with a pure *chrysoptera* should produce a mixed brood of *leucobronchiales* and *chrysopterae* and this was the composition of one of the two broods of mixed parentage whose history has been detailed in the foregoing pages. The same result would ensue from other combinations, *e. g.* an F_2 *leucobronchialis*, pW PW, mated with an impure *chrysoptera*, pW pw.

[1] It is a curious fact that intermediates between *leucobronchialis* and *chrysoptera* are almost unknown. Mr. Brewster (Bull. Nuttall Orn. Club, 1881, **6**, p. 219, and Dr. Fisher, (Id., p. 245) have recorded a specimen of *leucobronchialis* with black auriculars like *chrysoptera*; Mr. Ridgway in his article in the Auk, 1885, **2**, p. 363, seems inadvertently to have referred to this case as two. Dr. Townsend (Auk, 1908, **25**, p. 65–66) mentions a female *leucobronchialis* in Mr. Brewster's collection with faint grayish cheek patches. On the other hand *leucobronchialis*, especially in Connecticut, grades into *pinus* by a complete series of intermediates. Whether the Law of Dominance would cease to operate as a result of long continued breeding-in of the hybrid with *pinus* I leave to the consideration of those who are better versed in Mendelism than I am. I have little doubt, after surveying the whole genus *Helminthophila* and taking into account the color of the juvenile plumage of all the species, that the yellowish under parts are an ancestral feature. That an ancestral character should be suppressed as a recessive at the first crossing is not remarkable. The same thing has been shown to happen in crossing breeds of barn-yard fowl.

A homogeneous brood of *leucobronchiales*, like the other brood of mixed parentage I studied, might be the progeny of an F_2 *leucobronchialis*, PW Pw, mated with a pure *chrysoptera* or of a pure *leucobronchialis*, PW PW, (if there be such a thing[1]) mated with any *chrysoptera*. Or it is possible that the homogeneity of this brood arose from the number of young being too small to calculate averages from, or in other words too few to show the possible range of variation.

Other instances of the prevalence of the Law of Dominance in the inheritance from mixed unions are furnished by the published records. Mr. Chapman's case (No. 1, p. 68) of *pinus* ♂ mated with *leucobronchialis* ♀ was pretty well established. Three of the young which were shot June 26 were young *pinus*, and a *leucobronchialis* secured in the same spot at a later date Mr. Chapman thinks may have been the remaining bird of this brood.

Pw pW × Pw

|

2 *leuco.*, 2 *pinus*

Brewster, (case 1, p. 70). *Lawrencei* ♀ with a *leucobronchialis* juv. The father in this case was probably a *leucobronchialis*.

pw pw × Pw pW

|

pinus, chryso., leuco.,
lawrencei, in equal nos.

If a pure *leucobronchialis* (PW PW) *all* the young should be *leucobronchiales*.

Fisher, (case 2, p. 70). *Chrysoptera* ♀ feeding a young *pinus*. Another of the young resembled the mother. This may have been a case of an impure *chrysoptera* (pw pW) mated with an impure *pinus* (pw Pw). The offspring in this case should include *chrysoptera* and *pinus* in equal proportion.

Bishop, (case 3, p. 70). *Leucobronchialis* feeding two young (July 4), apparently *H. pinus*. In one the wing-bars were white, in the other they were broader and light yellow [*leucobronchialis*?]. The unknown parent in this case was probably a *pinus*. *Cf.* case 1, Chapman, p. 68.

Dwight, (case 5, p. 71). *Pinus* feeds young, one of which is *pinus* another *lawrencei*. An impure *pinus*, pw Pw, mated with a *lawrencei*, pw pw, should produce young *pinus* and *lawrencei* in equal numbers, by Mendel's Law.

It has been already noted on page 69 that Mr. Sage had the good fortune

[1] A pure *leucobronchialis*, PW, in the Mendelian sense, must be the offspring of a *pair* of *leucobronchiales*, a conjunction never yet observed.

to discover a *chrysoptera* mated with a *pinus* breeding at Portland, Conn., in June, 1889. Five young, the issue of this pair, were secured the day they left the nest, and they have been kindly loaned to me by Mr. Sage (Coll. J. H. Sage, nos. 1321–1325, 2 ♂, 3 ♀; one of these, no. 1321, is represented on the Plate, fig. 4). There is but slight variation in color amongst them. They are grayish olive on the crown, sides of the head, and back. The chin, throat, breast, and flanks are grayish olive, lighter than the back. The median part of the belly yellow. Remiges slate brown, edged with whitish and olive. Wing-bars olive-yellow. Young *H. pinus* of the same age, for the use of which I am indebted to Dr. J. Dwight, Jr., and Mr. William Brewster,[1] are olive on the crown, sides of the head and back, yellow-olive on the chin, throat, breast and flanks, yellow on the belly. The remiges are slaty brown edged with whitish olive. The wing-bars are olive-yellow. Compared with Mr. Sage's birds the young *pinus* are distinctly different, being more deeply suffused with yellow throughout.

I have no skins of the Lexington Brewster's Warblers in their juvenile plumage to compare with the young of *pinus* and with Mr. Sage's specimens. Since it was my object to determine what each one of the young birds developed into as adults, none were killed before attaining the first-winter plumage. Nevertheless, careful notes of the color of the young birds, taken when they had just quit the nest, reinforced by a vivid recollection of their appearance, convince me that they were like Mr. Sage's birds, distinctly grayer than the young of *pinus*. How do these young birds in their juvenile dress, that is, young *pinus* and Mr. Sage's birds, compare with the young of *chrysoptera* at the same age? I have been able to obtain but two specimens of *chrysoptera* in juvenile plumage, one from Mr. Brewster (No. 4669, Highland Falls, N. Y.) and one from the Carnegie Museum, Pittsburg, Pa. (No. 7100, Beaver Co., Pa., W. E. C. Todd),[2] and these are both considerably older and larger than the young *pinus* and the Sage birds, their tails being 1.1 inches in length. The Carnegie Museum specimen is shown on the plate, fig. 2. Their crowns, and the sides of their heads are dull olive-brown; back a shade or two darker; chin, throat, breast, fore belly, and flanks dull olivaceous ash; middle of belly and vent whitish; tail slate-colored with the three external pairs of quills extensively white on the inner webs; remiges slaty brown, edged exteriorly with olive, middle and greater wing-coverts tipped with yellowish. The black lores of the following first-

[1] One of Dr. Dwight's specimens is shown in Fig. 3 of the accompanying plate.

[2] I would also acknowledge the courtesy of Mr. F. M. Chapman of the American Museum, New York, and Mr. H. C. Oberholser of the U. S. Biological Survey, Washington, who have sent me skins of young *Helminthophilae* to examine.

winter plumage are already beginning to show in the form of small, sprouting pin feathers. There is no trace of the throat- and cheek-patches in this plumage but the color that overspreads the chin, throat, breast, fore abdomen, and flanks is many shades darker than in even Mr. Sage's specimens. The dorsal surface, too, is darker, while the middle line of the posterior part of the abdomen is whiter,— less heavily tinted with yellow. As the *chrysopterae* are considerably older, the differences in the colors may be in part due to the wear of the delicate juvenile feathers or to the exposure of the deeper parts of the feathers as the body of the bird enlarges. Mr. Outram Bangs has pointed out to me that a change in color such as is here assumed, involving a passage from a lighter and yellower to a darker and more ashy hue, really takes place in the juvenile dress of *Helminthophila rubricapilla* as the young bird grows. Observations made by Mr. C. J. Maynard, moreover, confirm me in this belief. In his "Warblers of New England," 1901, pp. 77, 80, Mr. Maynard describes the first plumage of *H. chrysoptera*, at the time of leaving the nest, as "pale golden ashy throughout, lighter on the abdomen. Tips of two rows of wing-coverts, golden, forming two wing-bars." This description was made by Mr. Maynard in the field, while the little birds were perched on the fingers of a friend. Now this description of the color of the earliest stage of the *chrysoptera* in its juvenile plumage does not well apply to the two older specimens of *chrysoptera* whose skins I have before me, but fits the Sage specimens pretty well. I am therefore led to believe that the latter are either *chrysoptera* or *leucobronchialis*, and not *pinus* for the reasons stated above. On *a priori* grounds one would expect the young of these two forms, *chrysoptera* and *leucobronchialis*, to be indistinguishable when they leave the nest, since except for the dark throat and ear patches (which do not appear until the first-autumn plumage) the adults of these two forms are alike.

Thus, through the lack of sufficient observations bearing on the relations of the birds under discussion, and the meagre material in collections to throw light upon the juvenile plumages, one is foiled at every step in this investigation. What is now wanted is for some one to follow up a young brood, the progeny of a *pinus* and a *chrysoptera*, until they have assumed the first-winter dress and so revealed their identity. To do this in the field is a long and laborious task and the circumstances may not always be such as ensure success. It were highly to be wished that experiments in breeding *pinus* with *chrysoptera* in an aviary would be undertaken in some place like Bronx Park, where facilities for such experiments are furnished. Yet even in that case grave difficulties are bound to present themselves. Unless each species is secured in a region where the

other is unknown, the experiments may be complicated and obscured through the chances of impurity of the parent stock. The long twelve-month intervals between successive generations, too, would place further obstacles in the path of him who tried to solve this problem by breeding the birds in confinement.

Mr. Brewster, arguing in 1881 in favor of the hybrid theory of *H. leucobronchialis*, closed his brief with the following words: "The bars are down; the gate stands open; 'he who runs may read.'" Yes, the gate stands open, but what I read is a sombre inscription over the portal:

LASCIATE OGNI SPERANZA, VOI CH' ENTRATE!

EXPLANATION OF PLATE.

Fig. 1. *Helminthophila leucobronchialis*. ♂. First winter plumage, Lexington, Mass., W. Faxon, July 14, 1910. Coll. Mus. Comp. Zoöl., No. 48385. The father of this bird was *H. chrysoptera* of typical plumage, the mother a typical *H. leucobronchialis*. × 1.

Fig. 2. *Helminthophila chrysoptera*. Juvenile plumage. Beaver, Pa., W. E. C. Todd, June 19, 1900. Coll. Carnegie Mus., No. 7100. × 1.

Fig. 3. *Helminthophila pinus*. ♀. Juvenile plumage. Near New York City, July 5, 1889. Coll. J. Dwight, Jr., No. 2285. × 1.

Fig. 4. *Helminthophila* (offspring of *H. pinus* ♂ and *H. chrysoptera* ♀). ♂. Juvenile plumage at time of quitting the nest. Portland, Conn., June 13, 1889. Coll. J. H. Sage, No. 1321. × 1.

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XL. No. 3.

THE CHISMOPNEA (CHIMAEROIDS).

BY

SAMUEL GARMAN.

CAMBRIDGE, U. S. A.:
Printed for the Museum.
September, 1911.

THE CHISMOPNEA (CHIMAEROIDS).

The classification of this group of the fishes with cartilaginous fins and the reasons for the same are indicated in the synopses given below.

Chondropterygii.

Chondropterygii (part) Linné, 1735, Systema, ed. 1; 1756, Syst., ed. 9, p. 41; Artedi, 1738, Syn. p. 89, Gen. p. 64; Gmelin, 1789, Linn. Syst., **1**, p. 1483.

Aquatic fish-like vertebrates in which the skeleton is cartilaginous and the skull without sutures; the heart has a conus anteriosus with three to four rows of valves; the brain has an optic chiasma; the intestine has a spiral fold; the teeth resemble the dermal armature and are not implanted in the cartilages of the jaws; the scales are placoid, and the vertical and the paired fins are mostly of horn-like tissue supported by cartilaginous radials; the eggs are large and fertilized internally, the male being provided with intromittent organs, claspers, attached behind the pelvis and the ventral fins; the embryo has deciduous gills.

Gill openings 5–7; gills 5–7; notochord more or less segmented
  Dorsal fins rigid, not erectile
    Teeth numerous; rostralia fused with the cranium, not articulated
      Upper jaws not fused with the skull
        Male without frontal and prepelvic tenacula . *Plagiostomia*
Gill openings one on each side; gills 4; notochord unsegmented
  Dorsal fin and spine erectile
    Teeth six, plate-like; rostralia three, articulated to the cranium
      Upper jaws and palatal cartilages fused with the skull
        Male with frontal and prepelvic tenacula . *Chismopnea*

Chismopnea.

Chismopnea Rafinesque, 1815, Analyse de la Nature, p. 92.
Holocephala Müller, 1834–1835, Vergl. Anat. Myx., **1**, p. 10.

Upper jaws and other palatal cartilages fused with the skull; rostral cartilages three, articulated to the skull. One gill opening; four gill clefts; four

gills, united with the skin distally; opercula rudimentary. Spiracles absent, except in certain embryonic stages. Dental laminae in three pairs, vomerine and palatine above and mandibular below. Brain massed posteriorly, more distributed forward, hemispheres distant from the optic lobes and attached to them by a nerve-like thread. Vertebrae imperfect, coalescent anteriorly. Sheath of the notochord not segmented. An erectile dorsal fin and spine the basalia of which are articulated to a consolidation of the neural spines above the pectoral fins. Oviparous. Male on approaching maturity developing claspers and a frontal tenaculum and two prepelvic tenacula adapted for clinging to the tail and the fins of the female. In some species the wide basal articulation of the frontal tenaculum prevents motion laterally and the hooked spines below its forward end are met by other sharp spines from within the cradle or receptaculum, thus indicating decisively the manner of use and the purpose of the organ. Skin naked in adults, a series of small spines, arranged in two rows along the middle of the back and on the top of the head, aid the escape from the egg shell.

Snout prominent, soft, without a proboscis
Brain with olfactories and hemispheres close together
Notochord surrounded by rings
Teeth with tritors on their edges
Claspers of male trifid, rarely bifid . . *Chimaeridae*
Snout produced into a long beak
Brain with olfactories and hemispheres widely separated
Notochord with rings
Claspers simple . . . . . *Rhinochimaeridae*
Snout produced into a leaf-shaped, flexible appendage
Brain with olfactories and hemispheres widely separated
Notochord without rings
Teeth with tritors on their sides
Claspers simple . . . . . *Callorynchidae*

Chimaeridae.

Chimeria Rafinesque, 1815, Anal. Nat., p. 92 (= Chimaera and Mormyrus, = subfam.).
Chimaerae Thien., 1828, Zoologie, p. 412 (= Chimaera and Callorhynchus).
Chimaeridae Bonap., 1831, Saggio, p. 98, 121 (= Chimaera and Callorhynchus).
Chimaeridae Garm., 1901, Proc. N. E. Zoöl. Club, **2**, p. 76 (= Chimaera).

Head moderately pointed, without a proboscis. Body compressed, tapering to a point at the tail. Pectoral fins large, free. First dorsal fin short, with

a strong spine, erectile, near the head. Second dorsal low, elongate. Caudals narrow, tapering; subcaudal without a produced lobe. Anal small or indistinct. Teeth all receiving impact on the edges. Mandibulars, palatines, and vomerines with tritors on the forward edges of the laminae. Lateral line an open canal, specially modified in the apertures on the head. Tail with or without a filamentary appendage. Vertebral axis in the tail on about the same level as that of the body. Notochord surrounded by narrow rings. Hemispheres of the brain close to the olfactories, more distant from the optic lobes. Claspers of the male trifid, rarely bifid. Males with erectile frontal and prepelvic tenacula.

Chimaera.

Chimaera Linné, 1754, Mus. Ad. Frid., **1**, p. 53; 1758, Systema, **1**, p. 236; 1766, Syst., **1**, p. 402.

Snout soft, prominent, not produced. Mouth inferior. Tritors on the dental laminae in the form of rods. Lateral line of the head with zigzag openings. Anal fin present and distinct; or united with the subcaudal; or rudimentary.

Anal fin distinct from the subcaudal
- Caudal filament long
  - Eyes large
    - Second dorsal not indented on the upper margin
      - Lateral line in short waves on the flank
        - Claspers divided two thirds of their length
          - Mottled, clouded, and banded with brown — *monstrosa*
      - Lateral line irregular, not waved
        - Claspers divided one third of their length
          - Iridescent dark brown, with lighter streaks on tail — *purpurascens*
          - Mottled with light, tail with light streaks — *owstoni*
      - Lateral line in short waves on the flank
        - Claspers divided one half their length . . . *phantasma*

Anal fin not distinct
- Caudal filament long
  - Eyes large
    - Second dorsal not indented
      - Lateral line not in short waves
        - Claspers trifid half their length . . *mitsukurii*

Lateral line not waved
Blackish with lines and spots of white . *australis*
Lateral line irregular
Claspers trifid, each branch expanded
Blackish with white spots . . . *barbouri*
Eyes large
Second dorsal deeply indented
Dark brown . . . . . *mirabilis*
Eyes moderate
Lateral line in short waves on the flank
Brownish with spots and narrow bands . *ogilbyi*
Caudal filament short
Eyes small
Second dorsal not indented
Lateral line with few and weak undulations
Leaden brown . . . . . *gilberti*
Brownish . . . . . *affinis*
Brown . . . . . *waitei*
Eyes large
Second dorsal fin divided
Brown with white spots
Claspers appearing bifid . . . . . *media*
Second dorsal deeply indented, not divided
Brown with white spots
Claspers bifid, two branches joined as one . *collici*

Chimaera monstrosa.

Simia marina Gesner, 1558, Hist. An., **4**, p. 1053; Aldrov., 1613, Pisc. and Cet., p. 405; Jonst., 1649, Pisc. and Cet., p. 29, pl. 6, f. 6.

Galeus piscis exoticus Clusius, 1605, Exot., p. 136; Jonst., 1649, *loc. cit.*, pl. 45, f. 2.

Centrina Aldrov., 1613, *loc. cit.*, p. 402, 403.

Galeus acanthias clusii exoticus Will., 1686, Hist. Pisc., p. 57, pl. B9, f. 6; Ray, 1713, Syn. Pisc., p. 23.

Chimaera monstrosa Linné, 1754, Mus. Ad. Frid., **1**, p. 53, pl. 25; 1758, Systema, **1**, p. 236; 1766, Syst., **1**, p. 401; Müll., 1774, Nat. Syst., **3**, p. 276; Müll., 1776, Zool. Dan. Prodr., p. 38; 1779, Neuer Schauplatz, **8**, p. 86; Bloch, 1785, Ausl. Fische, **1**, p. 61, pl. 124; Daub., 1787, Encl. Meth., Poiss., p. 202; Bonn., 1788, Ichth., p. 13, pl. 8, f. 25; Gmel., 1789, Linn. Syst., **1**, p. 1488; Walb., 1792, Art. Gen. Pisc., p. 587; Schn., 1801, Bl. Ichth., p. 349; Turt., 1806, Syst. Nat., **1**, 913; 1807, Brit. Fauna, p. 114; Don., 1807, Brit. Fish, pl. 111; Risso, 1810, Ichth. Nice., p. 53; Cuv., 1817, R. Anim., **2**, p. 140; 1829, R. Anim., **2**, p. 382; Rosenth., 1824, Ichthyot. taf., III, p. 16, taf. 27; Anslyn, 1828, Syst. Beschr., Vissch., **4**, p. 62; Flem., 1828, Brit. Anim., p. 172; Faber, 1829, Fisch. Isl., p. 41; Nilss., 1832, Prodr., p. 112; 1855, Skand. Fisk., p. 705; Jen., 1835, Man., 494; Bennett, 1839, Beechey's Voy., Fishes, p. 72, pl. 23, f. 3; Bonap., 1841, Fn. Ital., Pesci, pl. —;

Agass., 1844, Poiss. Foss., **3**, p. 337, pl. C; Gray, 1851, Chond., p. 21; Costa, 1852, Fn. Nap., Pesci, Chim., p. 4, pl. 1–7; Kröy., 1853, Danm. Fiske, **3**, p. 784; Dum., 1865, Elas., p. 686; Cap., 1868, Jorn. Ac. Lisb., **2**, p. 138; Günt., 1870, Cat., **8**, p. 349; Canest., 1872, Ital., Pesci, p. 62; Coll., 1875, Norg. Fiske, p. 206; Poey, 1876, Ann. Soc. Esp., **5**, p. 182, pl. 8; 1866, Repert., **1**, p. 242; Hubrecht, 1876, Ned. Arch. Zool., **3**, p. 255, pl. xvii, f. 2, 3, 5; Malm, 1877, G. och B. Fn. Rygg., p. 605; Winth., 1879, Prodr. Ichth. Dan., p. 56; Gigl., 1880, Elenc. Pisc., p. 51; Mor., 1881, Poiss. Fr., **1**, 455; Dod., 1881, Man., **2**, p. 16; Day, 1884, Brit. Fishes, **2**, 286, pl. 151; Vaill., 1887, Poiss. Trav. and Tal., p. 80, pl. 4, f. 2; Garm., 1888, Bull. M. C. Z., **17**, p. 73, pl. 2; 1904, Bull. M. C. Z., **41**, p. 272, pl. 7, f. 1–2, pl. 11, and pl. 13, f. 1; Holt and Cald., 1895, Trans Roy. Dub. Soc., (2) **5**, p. 368; Goode and Bean, 1896, Oc. Ich., p. 31; Jord. and Everm., 1896, Bull. 47 U. S. Nat. Mus., p. 94.

Callorynchus atlanticus Gronovius, 1772, Act. Helvet., **7**, p. 49; Gray, 1851, Gron. Cat., p. 16.
Callorynchus americanus Gron., 1772, *loc. cit.*, p. 49.
Chimaera argentea Ascan., 1772, Icon., pl. 15.
Le Roi des Harengs du Nord Daub., 1787, Encl. Meth., Poiss., 202.
Chimaera praecisa Walb., 1792, Art. Gen. Pisc., p. 588.
La Chimère Arctique LaC., 1798, Poiss., **1**, 392, pl. 19, f. 1.
Chimaera borealis Shaw; 1804, Zool., **5**, pt. 2, p. 365, pl. 157.
Northern Chimaera Shaw., l. c.
Chimaera mediterranea Risso, 1826, Hist. Nat. Eur. Mér., **3**, p. 168.
Rabbit-Fish Flem., 1828, Brit. Anim., p. 172.
Chimaera cristata Faber, 1829, Fisch Isl., p. 45.
King of the Herrings Yarr., 1836, Brit. Fish., **2**, 364.
Callorynchus centrina Gray, 1854, Gron., Cat., p. 15.
Arctic Chimaera Couch, 1867, Brit. Fish, **1**, 145, pl. 34.

Chimaera monstrosa, the type species of the genus, has the head compressed, subconical; snout soft, rather blunt, without rostral appendages; body compressed; caudal section tapering from the body-cavity to a long filament at the end of the tail. First dorsal fin triangular, close to the head, short, deep, preceded by a strong erectile spine and followed by a low dermal fold. Second dorsal low, three times as long as the head, extending two thirds of the length above the caudal region; not indented on the upper margin, reaching above the origin of the caudal. Length of body from end of snout to origin of supracaudal about five times the length of the head. Caudal fins low, rising slowly in front, and descending very gradually backward. Anal small, rising slowly, separated by a narrow notch from the subcaudal. Ventrals far in the forward half of the total length; claspers of the male trifid nearly two thirds of their length, the third section being slender and styliform. Pectorals large, one and one third times or more as long as the head, reaching behind the origins of the ventrals; hinder-margins slightly concave. Lateral line less wavy than in *C. phantasma*. Eye large, lateral. Dorsal spine nearly as long as the head, denticulate on the hinder edges, reaching behind the origin of the second dorsal. Five to seven tritors on each of the vomerine dental laminae. Attaining a length of three feet and upwards.

Brown, reddish to silvery or golden on the upper surface; more or less clouded and blotched with brown, irregularly scattered or in longitudinal streaks;

fins with darker outer margins. Varying much in individuals; sometimes plain on the back shading to silver-white or yellow below.

Northern Atlantic, from the Mediterranean and Cuba to Norway and Iceland, descending to depths of 600 fathoms or more.

Chimaera purpurascens.

Chimaera purpurascens Jordan and Snyder, 1904, Smith. Misc. Coll., **45**, p. 235 (name and note of color)
Chimaera jordani Tanaka, 1905, Journ. Coll. Sci. Tokyo, **20**, p. 2, pl. 1, f. 1; 1911, Fishes of Japan, **1**, pl. X, f. 30.

Head one fifth of the length from the snout to the caudal fin, or nearly one third of the length of the second dorsal fin. Dorsal spine as long as the head, reaching when applied to the back behind the origin of the second dorsal. Base of first dorsal twice as long as the interdorsal space, which latter is traversed by a dermal fold. Anal separated by a notch from the subcaudal. Claspers of male trifid one third of the length, hardly longer than the ventral fin. Eye large, two sevenths of the head length. Subcaudal fin hardly as deep as the supracaudal fin. Lateral line irregular with few and weak undulations; jugular branch joining the orbital near the junction of the latter with the angular and the suborbital branches.

Dark brown, with light streaks lengthwise below the lateral line on the tail.

Japan.

Chimaera owstoni.

Chimaera owstoni Tanaka, 1905, Journ. Coll. Sci. Tokyo, **20**, p. 10, pl. I, f. 2, 3; 1911, Fishes of Japan, **1**, p. 18, pl. V, f. 17, 18.

Head little more than one fifth of the length from the end of the snout to the caudals, and more than one third of the base of the second dorsal. Dorsal spine as long as the head, reaching beyond the origin of the second dorsal. Dorsals joined by a fold between them, its length less than that of the first dorsal base. Pectorals long, reaching little beyond the origin of the ventrals. Claspers of male short, trifid less than half their length, second branch smaller than the club-shaped first one, third branch styliform, pointed, crooked at the end. Anal separated from the subcaudal. A caudal filament. Upper outline of the second dorsal slightly concave near the middle of its length. Caudals subequal in depth. Lateral line rather irregular, but not wavy; jugular branch meeting the orbital near the junction of the latter with angular and suborbital.

Brown with lighter spots on body and head, with a lighter streak along the base of the second dorsal and with another one above and two or three other similar ones below the lateral line on the tail between ventrals and caudal.

A close ally if not a variety of the preceding.

Japan.

Chimaera phantasma.

Chimaera monstrosa Schlegel, 1850, Poiss. Jap., p. 300, pl. 132.
Chimaera phantasma Jordan and Snyder, 1900, Proc. U. S. Nat. Mus., **23**, p. 338; 1904, *ibid.*, **27**, p. 223; Dean, 1904, Journ. Coll. Sci. Tokyo, **19**, p. 3, pl. I, f. 3, 4.

Head nearly one fourth of the length from snout to end of second dorsal, equal to two fifths of the length of the second dorsal base; equals more than the depth of the body, or to nearly four times the length of the orbit. First dorsal rather small, spine reaching the origin of the second dorsal. Height of second dorsal about equal to that of the orbit; upper margin not concave. Caudal filament more than twice as long as the head; caudal fins narrow, hardly one third of the length of the orbit in width. Anal fin narrow, small, distinctly separated from the subcaudal. Pectorals wide, reaching behind the bases of the ventrals, hind margins slightly concave. Outer angles of the pectorals and the ventrals rather sharp. Claspers of male twice as long as the ventral fin; divisions extending more than half their length. Waves in the lateral line along the flank short and shallow. The supracaudal fin is a very little deeper but much shorter than the subcaudal; the latter being continued for a long distance below the filament.

Greyish brown, somewhat streaked or blotched longitudinally on the flanks; with or without small spots or vermiculations of darker near the bases of the dorsals. Several streaks of darker on the caudal section. Lateral line dark.

Sagami Bay, Japan. Alan Owston.

Chimaera mitsukurii.

Chimaera phantasma Jordan and Fowler, 1903, Proc. U. S. Nat. Mus., **26**, p. 669.
Chimaera mitsukurii Jordan and Snyder, 1904, Proc. U. S. Nat. Mus., **27**, p. 234, f. 2; Dean, 1904, Journ. Coll. Sci. Tokyo, **19**, p. 6, pl. 1, f. 1–2.

Head approximating one fifth of the length from snout to end of second dorsal, little less than one third of the length of the base of the latter fin. Second dorsal not indented on the upper border. Pectorals reaching behind the bases of the ventrals. Anal not distinct. Caudal filament more than three times the

length of the head. Supracaudal little deeper than subcaudal. Dorsal spine reaching behind the origin of the second dorsal. Eye large, length more than one third of that of the head, twice the height of the second dorsal. Lateral line not wavy, but slightly irregular; jugular section meeting the angular a short distance below the junction of orbital and angular. Clasper of male extending little behind the ventral fins, trifid about half of its length.

Silvery brown, whiter below; fins darker outwards.

Sagami Bay, Japan.

Chimaera australis.

Chimaera monstrosa var. *australis* Hector, 1902, Trans. and Proc. New Zeal. Inst., **34**, p. 239, pl. 14, C, D; Waite, 1907, Rec. Cant. Mus., **1**, p. 9.

Measurements taken from the type are: total length 36, depth 4, snout to orbit 2.5, snout to dorsal spine 6, dorsal spine 3, base of dorsal 3.5, interdorsal space 3, base of second dorsal 16, snout to pectoral 5, snout to ventral 16, caudal fin 5, and filiform appendage 7 inches.

Hector's text describes *Chimaera monstrosa* var. *australis* without interrogation marks. The measurements were taken from the female specimen, the text from both sexes, as also the outlines on the plate. The figures given are named "Chimaera colliei (= C. monstrosa *var.* australis ?) female. D.— male." The outlines exhibit a short second dorsal without indentation on the upper edge, an indistinct anal fin, and, on the male, a bifid clasper and a continuous second dorsal and supracaudal.

"Colour.— Olive-black above, silvery-white beneath the head, and dark-grey elsewhere. Head with small ocellated spots, and round the base of the dorsal five distinct white spots. As far back as the vent three rows of nine spots in each, and one broad but interrupted line of white. A pseudo-lateral line of fifty-three pores marked by golden scales, which latter are also found on other parts. On the tail are thirteen bold white blotches, in continuation of the white lateral line on the body."

Wairau Bay. New Zealand.

Chimaera barbouri.

Chimaera barbouri Garman, 1908, Feby., Bull. M. C. Z., **51**, p. 255; Tanaka, 1911, Fishes of Japan, **1**, p. 16, pl. 4, f. 14, pl. 5, f. 19.
Chimaera spilota Tanaka, 1908, March, Journ. Coll. Sci. Tokyo, **23**, p. 15.

Head little more than one fifth of the length to the end of the second dorsal, two fifths of the second dorsal base. Second dorsal two and one half times as

long as the head; greatest depth equal length of orbit, depth in the mid length half as much; border rising posteriorly to nearly the anterior height. Pectorals large, reaching the bases of the ventrals, hind margins slightly concave. No distinct anal. Dorsal fins united by a low fold; interdorsal space shorter than the base of the first dorsal. Dorsal spine about two thirds as long as the head. Eye two sevenths the length of the head. Supracaudal fin slightly the deeper; subcaudal the longer; a caudal filament. Lateral line irregular, but not in short waves; jugular branch meeting the postorbital near the junction of the latter with the suborbital and the angular. Claspers of male short, stout, trifid more than half their length; the three branches being somewhat similarly expanded toward the distal end.

Blackish, with spots of white on the flanks.

Japan: Aomori, near Tsugaru Strait; Off Ōtsu, Province Hitachi.

Chimaera mirabilis.

Chimaera (*Bathyalopex*) *mirabilis* Collett, 1904, Forh. Vid. Selskr., Chra., No. 9; 1905, Report on the Norwegian Fishery and Marine-Investigations, **2**, p. 35, pl. 1, f. 4.

Head nearly two ninths of the length from snout to supracaudal, little more than one third as long as the second dorsal base. Outer angles of pectorals rather blunt, hind margins convex. Ventrals convex posteriorly. Interdorsal space short. Pectorals long, reaching behind the origins of the ventrals. Subcaudal longer, deeper, and extending farther forward than the supracaudal. Caudal filament long. No anal fin. Lateral line bending abruptly upward close behind the junction with ocular and orbital; jugular section meeting the angular, at a distance below the junction of the latter with the orbital and the suborbital sections. Forehead prominent in front of the eye. Orbit large, half as long as the head, in an individual 432 mm. long. Dorsal spine as long as the base of the fin, two thirds as long as the head, reaching the origin of the second dorsal. Height of anterior and posterior portions of second dorsal about half the length of the orbit, the concave middle portion descending to about one third the height of the anterior. Dorsal notch hardly separating the two dorsals.

Greyish brown, fins darker.

Faroe Channel; Faroe Bank, at 750–1200 metres.

Chimaera ogilbyi.

Chimaera ogilbyi Waite, 1898, Thetis Prelim. Report, p. 56; 1899, Mem. Austral. Mus., 4, p. 48, pl. 6.

Head one fourth of the length from snout to supracaudal, about three sevenths of the length of the second dorsal. Eye small, length near one fifth of the head. Upper margin of second dorsal not indented. Outer angles of pectorals and ventrals sharp. No anal fin. Caudals low, supracaudal little higher than subcaudal. Pectorals reaching beyond the origins of the ventrals. Dorsal spine hardly reaching the base of the second dorsal. Lateral line with short waves on the greater part of the flank; jugular section meeting the orbital near the junction of the latter with angular and suborbital sections. Caudal filament elongated.

Silvery on back and sides, yellowish below. Toward the back of the head on the body there are narrow darker bands passing down and obliquely forward. Anteriorly there are small spots which become rings farther down. Posteriorly the twenty or more transverse streaks above the lateral line are more or less broken.

Off N. S. Wales, at 22–26 fathoms.

Chimaera gilberti, nom. nov.

Chimaera purpurascens Gilbert, 1905, Bull. U. S. Fish Comm., pt. 2, p. 585, f. 231, not *C. purpurascens* Jordan and Snyder, 1904.

Named in honor of Professor Charles H. Gilbert.

Head less than one fourth of the length from snout to end of second dorsal. Eye one fifth as long as the head; front of orbit in mid length of head. Dorsal spine little more than half the length of the head, not serrated, reaching the base of the second dorsal. Greatest depth of second dorsal equal to the length of the orbit, upper border not concave. No separate anal. Pectoral large, reaching beyond the origins of the ventrals, not falciform, rather broad. Subcaudal larger than supracaudal. A caudal filament. Lateral line feebly undulated; jugular section meeting the angular at the junction with orbital and suborbital sections. Type 90 cm. in length.

Uniform purplish or plum color.

Off Kauai, Hawaii, at 957–1067 fathoms.

Chimaera affinis.

Chimaera affinis Capello, 1868, Jorn. Math. Phys. e Nat. Lisb., **4**, p. 314, pl. 3, f. 1, 1ª; Günt., 1870, Cat., **8**, p. 350; Jordan and Everm., 1896, Bull. 47 U. S. Nat. Mus., p. 95; Goode and Bean, 1896, Oc. Ich., p. 31, 509, pl. 10, f. 32–55.
Chimaera plumbea Gill, 1877, Dec. 22, Bull. Phil. Soc. Wash., **2**, p. 182; Jordan and Gilbert, 1883, Bull. 16 U. S. Nat. Mus., p. 54.
Chimaera abbreviata Gill, 1884, Proc. U. S. Nat. Mus., **6**, p. 254.

Head about three fourteenths of the length from snout to end of second dorsal. Bases of dorsals connected by a fold. Second dorsal not indented on its upper edge. Pectorals large, not reaching the bases of the ventrals. Outer angles of ventrals sharp. Dorsal spine more than half as long as the head, hardly keeled in front. Subcaudal about as wide as the supracaudal. No separate anal fin. Eye small, less than one sixth as long as the head. Caudal filament short. Lateral line with few and weak undulations; jugular branch meeting the postorbital near the junction of the latter with the suborbital and the angular sections. Clasper of male trifid in the distal third of its length.

Uniform plumbeous.

North Atlantic, from Portugal westward, in depths of from 300 to more than 900 fathoms.

Chimaera waitei.

Hydrolagus (*Psychichthys*) *waitei* Fowler, 1908, Proc. Acad. Nat. Sci. Phil., p. 419, f. 1.

Head three elevenths of the length from end of snout to end of second dorsal, little more than half of the second dorsal base. Dorsal spine as long as the head in a twelve inch specimen, keeled in front, reaching the origin of the second dorsal. No distinct anal. Subcaudal rather narrower than supracaudal. Caudal filament short. Eye small. Lateral line not wavy in the middle of the side; jugular section meeting the postorbital near the junction of the latter with the angular and the suborbital sections. Second dorsal not indented in the upper edge.

Type about twelve inches in length.

Coast of Victoria, Australia.

Chimaera media, sp. nov.

Eye large, length of orbit nearly one third of that of the head. Head about one fourth of the distance from snout to supracaudal, nearly half as long as the base of the second dorsal. Dorsal spine longer than the head on a female,

shorter on a male, keeled in front, hind edges serrated. Indentation of the upper margin of the second dorsal deeper than that of *C. collici*, dividing the fin into two distinct unequal sections of which the anterior is the shorter. No anal fin. Subcaudal slightly deeper and longer than the supracaudal; caudal filament rudimentary. Hind margins of ventrals slightly concave; outer edges of these fins longer on female, inner edge longer on male. Pectorals subfalciform, twice as long as wide, hind margin indented, outer angle sharp. Clasper of male trifid, similar in shape to that of *C. collici*, apparently bifid but having the second and third divisions free, not bound together by the skin. In other words the skin of the second division of the clasper is not fused around the distal end of the third division, though the two are closely connected with one another. Lateral line nearly straight along the flank; jugular section meeting the postorbital near the junction of the latter with the angular and the suborbital. Description taken from a female of 22 inches and an adult male of 20 inches.

Colors resembling those of *C. collici* but less red and more silver; spots of white are scattered on the sides much as in that species.

In shape and coloration these specimens resemble others of *C. collici*, but they are somewhat more elongate, have larger eyes, more falciform pectorals, divided second dorsals, and the clasper is completely trifid.

Types No. 330, Mus. Comp. Zoöl.

Locality uncertain.

Chimaera collici.

Chimaera collici Bennett, 1839, Beechey's Voy., Fishes, p. 71, pl. 23, f. 1–2; Gir., 1858, Pacific R. R. Rept., **10**, p. 360; Dum., 1865, Elas., 689; Günt., 1870, Cat., **8**, p. 350; Jordan and Gilbert, 1883, Bull. 16 U. S. Nat. Mus., p. 55; Garm., 1904, Bull. M. C. Z., **41**, p. 272; Dean, 1906, Chim. Fishes and Devel., pl. 1–11, figs.

Hydrolagus collici Gill, 1862, Proc. Acad. Nat. Sci. Phil., p. 331 (name only); Jordan and Everm., 1896, Bull. 47 U. S. Nat. Mus., p. 95; Goode and Bean, 1896, Oc. Ich., p. 32, pl. 10, f. 36.

Eye rather large, two sevenths or less of the length of the head. Head nearly one fourth of the length from snout to supracaudal, little more than half the length of the second dorsal. Pectorals broad, not twice as long as wide; hind margin slightly convex near the outer angle. Outer ends of the ventrals rounded; claspers of male short, not reaching end of ventral fin; apparently bifid more than half their length, the cartilages being trifid but two of the three being bound together by the skin at their distal ends. Sub- and supracaudals about equal in height. Second dorsal nearly twice the length of the head, highest forward, continuous, but descending in the mid length to about one fourth of

the anterior height then rising to about three times the height of the middle portion. Interdorsal space equal to the base of the first dorsal, traversed by a low fold. Vomerine teeth with from five to seven rods. Lateral line on the flank nearly straight; jugular section meeting the postorbital near its junction with the suborbital and the angular. Dorsal spine not reaching the origin of the second dorsal. Anal rudimentary or absent.

Back brownish, shading to white or yellowish below; sides with numerous irregular rounded spots of white or yellow.

Near the shores, California and northward.

Rhinochimaeridae.

Rhinochimaeridae Garman, 1901, Proc. N. E. Zoöl. Club., **2**, p. 77; 1904, Bull. M. C. Z., **41**, p. 270.

Head elongate. Snout much produced, in a slender point. Pectorals large, free. First dorsal with a strong, erectile spine, fin short, close to the skull. Second dorsal low. Anal not distinct from the subcaudal. Subcaudal well developed, without a produced lobe. Caudals tapering backward to a filament. Lateral line an open groove with closely set ribs. Notochord surrounded by narrow rings, unsegmented.

Hemispheres of the brain remote from the olfactories and the optic lobes, connections very slender. Males with a frontal tenaculum and prepelvic tenacula. Claspers of the male slender, distally ending in a volute knob with hooked spines.

Snout compressed

Cutting edges of vomerine plates not sinuous, without tritors

Upper edge of supracaudal spinose . . . *Rhinochimaera*

Snout depressed

Cutting edges of vomerines sinuous or notched, with tritors

Upper edge of supracaudal not spinose . . . . *Harriotta*

Rhinochimaera.

Rhinochimaera Garman, 1891, Proc. N. E. Zoöl. Club, **2**, p. 75.

This genus is distinguished by an elongate compressed snout, a nearly straight forehead; teeth without tritors, notches, or sinuations on their cutting edges; a low supracaudal fin the upper edge of which is armed with spines, and, on the male sex, by a shortness and straightness of the stem of the frontal tenaculum, induced by lack of curvature of the forehead.

Rhinochimaera pacifica.

Harriotta pacifica Mitsukuri, 1895, Zoöl. Mag. Tokyo, **7**, p. 97, fig.
Rhinochimaera pacifica Garm., 1901, Proc. N. E. Zoöl. Club., **2**, p. 75; 1904, Bull. M. C. Z., **41**, p. 247, pl. 1, pl. 2, f. 1–2, pl. 3, f. 1, 4–5, pl. 4, f. 2–4, pl. 5, f. 1–2, pl. 8–9, pl. 12, pl. 14.
Rhinochimaera (*Harriotta*) *pacifica* Dean, 1904, Journ. Coll. Sci. Tokyo, pl. 1–2.

Snout narrow, high, produced, pointed. Body, head, and snout compressed; back hardly elevated above the level of the snout and the tail. Forehead continuous into the snout, not decurved. First dorsal subtriangular; spine not reaching the origin of the second dorsal. Second dorsal low, hardly as wide as the orbit, little longer than the snout, as long as the space between the origins of the pectorals and those of the ventrals. Ventrals small, nearly as large as the first dorsal. Pectorals large, broad, not reaching the origins of the ventrals. Supracaudal very low, armed on the upper edge with spines, in a double row. Subcaudal much larger, longer, and wider; width about that of the orbit. Caudal filament about as long as the snout. No anal fin. Lateral line nearly straight from the ocular and the orbital sections backward to a point below the origin of the supracaudal; jugular section meeting the orbital a short distance behind the junction of the latter with the suborbital and the angular; prenasal section not passing up on the side of the snout but continued forward between the nasal and the suborbital to the subrostral. See figures in Garman, 1904, Bull. M. C. Z., **41**, pl. 2, f. 1 and 2. Teeth with sharp cutting edges, without notches or undulations, Garm., *loc. cit.*, pl. 5, f. 1 and 2. An adult male is about three feet in length, a female about four.

Sides and below light silvery olive or plumbeous brown; back, tail and fins distally darker.

Japan.

Harriotta.

Harriotta Goode and Bean, 1904, Proc. U. S. Nat. Mus., **17**, p. 471.

The snout in this genus is elongate, depressed, and somewhat flattened; the forehead curves down in front to the snout; the teeth have tritors and sinuous or notched cutting edges; the supracaudal is of moderate height and not armed by spines on its upper edge, and the frontal tenaculum of the male has an elongate much curved stem to comport with the downward curvature of the forehead.

Harriotta raleighana.

Harriotta raleighana Goode and Bean, 1894, Proc. U. S. Nat. Mus., **17**, p. 472, pl. 19; 1896, Oc. Ich., p. 33, pl. xi; Jordan and Everm., 1896, Bull. 47, U. S. Nat. Mus., p. 96, pl. 19, f. 42; Garm., 1904, Bull. M. C. Z., **41**, p. 263, pl. 2, f. 3–5, pl. 4, f. 1, pl. 5, f. 3–9; Dean, 1906, Chim. Fish and Devel.; Bean and Weed, 1910, Proc. U. S. Nat. Mus., **37**, p. 662, pl. 38.

Body and head compressed. Snout much produced, depressed, pointed. Forehead prominent, curving downward from crown to snout. First dorsal high, short, subtriangular. Second dorsal low, elongate, nearly as long as the head and snout together. Pectorals large, reaching the origins of the ventrals. Ventrals small. No anal. Supracaudal low, about half as wide as the subcaudal, without spines on its upper edge; subcaudal much wider and longer, origin near a vertical from the end of the second dorsal. Lateral line nearly straight along the middle of its length; prenasal branch passing from the nasal outward in a broad curve to the side of the snout, between the suborbital and the nasal, where it continues forward and curves inward to the subrostral; jugular section meeting the orbital behind the junction of the latter with the suborbital and the angular. Each vomerine tooth with from seven to nine tritors (rods) on the cutting edge. Palatine teeth with three more or less complete longitudinal series of tritors: the outer of small rounded tritors on the cutting edge, the second of small ones forward and large broad ones, forming a pavement, backward, the third irregular, composed of small and short tritors. The mandibular teeth have a series of rods on the cutting edge in the forward half, and two series of tritors in the posterior half, the inner being continuous with the forward series and composed of broad pavement-like tritors. The very young have no tritors and the numbers and shapes vary greatly with age. As with other chimaeroids the young have two rows of dorsal scales.

Brown.

Off the Coast of the United States, in the Western North Atlantic, 707 to 1080 fathoms.

Harriotta chaetirhamphus.

Anteliochimaera chaetirhamphus Tanaka, 1909, Journ. Coll. Sci. Tokyo, **27**, 8, p. 7, pl. 1; 1911, Fishes of Japan, **1**, p. 10, pl. III, f. 11, pl. IV, f. 15–16.
Harriotta chaetirhamphus Bean and Weed, 1910, Proc. U. S. Nat. Mus., **37**, p. 661, pl. 39.

Snout much produced, depressed, pointed. Body elongate, compressed, back not elevated. Forehead convex from crown to snout. Mouth small. Teeth with sinuate cutting edges; vomerines with six to seven rods; mandibulars

with three prominences, cutting edge adjoining the median prominence concave, "six distinct rods occur on both sides of the same prominence." Pectoral broad, reaching far beyond the origin of the ventral. Ventrals small, nearly equal to first dorsal. No anal fin. Supracaudal moderately developed, without spines on its upper margin; subcaudal much larger, longer, and more than twice as deep, origin farther forward near a vertical from the end of the second dorsal. Caudal filament four and one third times the diameter of the eye. Hind margins of pectorals and ventrals convex, outer angles bluntly rounded. Lateral line somewhat nearly straight; jugular section meeting the postorbital a short distance behind the junction of the latter with the suborbital and the angular. Frontal tenaculum of the male with a much curved stem, agreeing with the convexity of the forehead. Clasper simple, slender, reaching the hind margin of the ventral, with a rounded knob beset with prickles at the distal end.

Brownish, darker below, fins edged with blackish.

Type an adult male of more than 31 inches (80 cm.) Closely allied to *H. raleighana* if not identical.

Outside Okinose, Sagami Sea, Japan, in depths of 400 fathoms.

Harriotta atlantica.

Rhinochimaera atlantica Holt and Byrne, 1909, Ann. Mag. Nat. Hist., (8), **3**, p. 279.

"Diagnosis.—Adult male with the snout (measured between verticals from its tip to the origin of the vomerine dental plates) as long as the distance between the dorsal insertions of the pectoral and ventral fins and somewhat longer than the base of the second dorsal fin. Second dorsal fin with base about half as long as the distance between the gill-openings and the origin of the ventral lobe of the caudal fin. Posterior ventral claspers terminating in subconical slightly volute clubs. Vomerine dental plates deeply notched on their cutting edges."

The specimen described was about 45.8 inches (1165 mm.) in total length, nearly 34 inches from the end of the snout to the supracaudal fin. It was taken on the Irish Atlantic Slope. The description as given above would place the species in Harriotta rather than in Rhinochimaera. Probably the type represents a male of *Harriotta raleighana*, the largest species of Rhinochimaeridae known.

Callorynchidae.

Callorhynchidae Garman, 1901, Proc. N. E. Zoöl. Club, **2**, p. 77; 1904, Bull. M. C. Z., **41**, p. 271.

Head short, pointed; snout with a flexible proboscis ending in a retrorse leaf-shaped distal extremity. Body compressed, tapering backward and becom-

ing slender in the tail. Pectorals large, free. First dorsal near the occiput, short, with a strong spine, erectile. Second dorsal short. Anal fin farther back than the dorsal, distinct from the subcaudal. Teeth with the tritors receiving the impact on the sides instead of the edges. Tritors of palatines and mandibulars on the sides of the laminae. Lateral lines tubular. Notochord without rings. Hemispheres of the brain nearer to the optic lobes than to the olfactories, connections slender. Caudal axis slightly raised from the level of that of the body. Male with slender simple claspers, appearing as if rolled into a tube, jointed near the end; and with a frontal tenaculum and two prepelvic tenacula.

Callorynchus.

Callorynchus Gronovius, 1754, Mus. Ichth., **1**, p. 59; 1756, Mus. Ichth., **2**, p. 42; 1763, Zooph., **1**, p. 31; Linné, 1756, Systema, ed. 9, p. 42; Cuv., 1817, R. An., **2**, p. 140.

Until other genera are added the characters of the family are those of the genus. Body and head somewhat deeper than wide. Vomerine teeth unlike those of Chimaera, without the rods, so called. Mandibular and palatine dental laminae with one to two tritors each. In young stages, and in some species throughout life, the tritors are longitudinal parallel bars on the side of the lamina. With age and use in some species the tritors posteriorly expand until contiguous tritors of certain pairs meet and fuse to form doubled, u-shaped tritors with the prongs extended forward. Because of such changes the identification of species either living or fossil by the teeth should be undertaken only with great caution. These modifications were described and figured by Garman, 1904, Chismopnea, Bull. M. C. Z., **41**, p. 256–257, plates 6, 7. A more or less produced lobe on the subcaudal fin. Caudal filament moderate to short or absent. Frontal tenaculum of male with a wide stem and a broad articulation.

Tritors two on each palatine tooth, not fused in adults
  Pectoral fins not reaching the ventrals
    Tritors strong, longitudinally parallel bars . . . *smythii*
Tritors on the palatines fusing in adults
  Pectorals reaching beyond mid bases of ventrals
    Tritors with thick unequal prongs, outer shorter
      Origin of first dorsal little behind that of the pectoral
callorynchus
  Pectorals reaching nearly to mid base of ventrals
    Tritors with long slender pointed prongs, subequal
      Origin of first dorsal forward of ends of pectoral bases
capensis

Pectorals reaching nearly or quite to bases of ventrals

Tritors with short thick prongs, outer very short

Origin of first dorsal somewhat in advance of pectoral bases *milii*

Pectorals?

Tritors far back, on hinder half of lamina . . . . *tritoris*

Callorynchus smythii.

Pejegallo, Poisson Coq, Demoiselle, Elephant, Frezier, 1716, Relat. du Voy. de la mer du Sud aux côtes du Chily et du Perou, p. 110, f. A.

La Chimère antarctique Lac., 1798, Poiss., **1**, p. 100, pl. 12, f. 1.

Callorynchus callorynchus Cuv., 1817, R. Anim., **2**, p. 140.

Callorynchus smythii Bennett, 1839, Beechey's Voy., Fishes, p. 75, pl. 22, f. 3; Dum., 1865, Elas., 697; Garm., 1904, Bull. M. C. Z., **41**, p. 271, pl. vi, f. 1–4.

Callorynchus antarcticus Günt., 1870, Cat. **8**, p. 351 (part); Vaill., 1888, Miss. Sci. Cap Horn, Poiss., p. 16; Garm., 1888, Bull. M. C. Z., **17**, p. 74, pl. 3–4; Phil., 1892, Ann. Mus. Nac. Chile, pl. 4.

In specimens at hand the pectorals do not reach the ventrals by nearly the length of the orbit. The origin of the second dorsal is above the origins of the ventrals; the end of the base of this fin is a little forward from the anal. There is a slender caudal filament. The lateral line is affected by short waves between the ventrals and the anal below the second dorsal. The tritors of the dental laminae are commonly elongate bars, as in the young, not being swollen and fused posteriorly; thus there are two tritors on each of the palatine laminae where in other species there is but one. The colors vary greatly: in young individuals there may be black spots on the bases of the dorsals, on the tip of the second dorsal, in a row along the lateral line (4–5) from the second dorsal forward, and there may be a large spot below the eye with another above the pectoral; also one on each of the ventrals and one on the subcaudal. Large specimens are more or less uniform silvery and vary from light to dark.

Off the coasts of Chile and Peru.

Callorynchus callorynchus.

Callorynchus Gronovius, 1754, Mus. Ichth., **1**, p. 59, pl. iv; 1756, *loc. cit.*, **2**, p. 42; 1763, Zooph., **1**, p. 31, pl. iv.

Callorynchus callorynchus Linné, 1756, Systema, ed. 9, p. 42; Garm., 1904, Bull. M. C. Z., **41**, pl. 7, f. 7–9, pl. 10; Starks, 1906, Proc. U. S. Nat. Mus., **30**, p. 764.

Chimaera callorynchus Linné, 1758, Syst., **1**, p. 236; 1766, Syst., **1**, 402; Müll., 1774, Nat. Syst., **3**, p. 277; 1779, Neuer Schauplatz, **8**, p. 86; Daub., 1787, Enc. Meth., Poiss., p. 336; Bonn., 1788, Ichth., p. 14; Gmel., 1789, Linn., Syst., **1**, p. 1489; Walb., 1792, Art., Gen. Pisc., p. 634; Schn., 1801, Bl. Ichth., p. 350, pl. 68.

Chimaera australis Shaw, 1804, Zool., **5**, pt. 2, p. 368, pl. 158; Swains., 1838, Fishes, **1**, p. 126, f. 9b.

Chimaera elephantinus Bory, 1823, Dict. Class. d'Hist. Nat., **3**, p. 61; Gray, 1851, Chond., p. 15.
Callorynchus antarcticus Bennett, 1839, Beechey's Voy., Fishes, p. 75; Dum., 1865, Elas., p. 693 (part), pl. 13, f. 1, 2, pl. 14, f. 2; Günt, 1870, Cat. **8**, p. 351 (part); Hubrecht, 1876, Ned. Arch., Zool., **3**, 225; pl. xvii, p. 1, 4, 7, 9; Smitt, 1898, Exp. Terre de Feu, Poiss., p. 66, pl. vi, f. 43.
Callorynchus peronii Duméril, 1865, Elas., p. 694.
Callorynchus argenteus Phil., 1892, Ann. Mus. Nac. Chile, sec. 1, p. 11, pl. v, f. 1.
Le Roi des Harengs du Sud Daub., 1787, Encl. Meth., Poiss., p. 336; Bonn., 1788, Ichth., p. 14.

Pectorals reaching half way across the bases of the ventrals, longer than those of *C. smythii*, little shorter than those of *C. capensis*. Origin of the first dorsal slightly behind the origins of the pectorals. Origin of the second dorsal nearly above the origins of the ventrals; end of the base of the second dorsal somewhat farther forward than the origin of the anal. Subcaudal lobe produced to a point anteriorly, behind the anal. Interdorsal space about one and one fifth times the length of the base of the first dorsal. Dorsal spine about twice as long as the distance from the spine to the orbit. Each palatine lamina of the adult specimens at hand has but a single tritor; the fused portion of this is massive and broadly rounded; the prongs in front are rather short and thick, the outer one being especially so.

Lateral line irregular and waved much like that of *C. capensis*. The frontal tenaculum, as in all the species of the genus, when viewed from above is subtriangular, broad on the articulation, wide and short in the stem.

Brownish silvery. A dorsal band of deeper brown is interrupted by the fins, and younger specimens have a dark spot immediately in front of the dorsal spine and a dark area above the orbit. Very young are more spotted. Variations are numerous.

Off coasts of southern South America.

Callorynchus capensis.

Callorynchus capensis Duméril, 1865, Elas., p. 695, pl. 13, fig. 5-5ª; Garm., 1904, Bull. M. C. Z., **41**, p. 271, pl. 6, f. 5, 6.
Callorynchus antarcticus Günt., 1870, Cat. **8**, p. 351 (part).

Pectorals appearing long and pointed, reaching the bases of the ventrals and beyond. Origin of the first dorsal a little forward of the insertions of the pectorals; spine more than twice as long as its distance from the orbit, reaching two thirds of the distance from the origin of the first dorsal to that of the second. Origin of the second dorsal little behind a vertical from the origins of the ventrals. Lateral line decidedly irregular, with short bends.

On a thirty-three inch specimen the frontal tenaculum is not yet through the skin, the dorsal spine is one and one third times the length of the space between

the dorsals, but does not reach the second dorsal by about one fourth of the length of the spine; the pectorals reach the middle of the ventral base; the origin of the second dorsal is a little backward from the origins of the ventrals; the claspers are small, only half an inch in length, apparently less mature than the frontal tenaculum, and the ventral tenacula are foreshadowed by a very narrow slit in the skin below the bases of the fins. The palatine teeth are figured in the article on the Chismopnea, pl. 6, fig. 5–6; the longitudinal bars of the tritor have fused posteriorly; forward their extremities remain as slender subequal points. There is a slender caudal filament, shorter than the head.

Flanks plain silvery white, a trifle darker above the pectorals and forward toward the orbit. The dorsum is darker from the head to the caudal. The fins are darker and become lighter toward the hind borders.

The species named *C. hectori* by Newton, 1876, was founded on a fossil palatine tooth that cannot be distinguished from the teeth of the specimen from which the present notes are taken.

Cape Good Hope.

Callorynchus milii.

Callorynchus milii Bory, 1823, Dict. Class. d'Hist. Nat., **3**, p. 62, pl. v; Garm., 1904, Bull. M. C. Z., **41**, p. 266, 271, pl. 6, f. 7–8.
Callorynchus tasmaniensis Rich., 1841, Proc. Zool. Soc. Lond., p. 29; 1841, Trans. Zool. Soc., Lond., **3**, p. 174; Dum., 1865, Elas., p. 696.
Callorynchus australis Hobson, 1842, Tasm. Journ. Sci. Agr. Stat., **1**, p. 14; Owen, 1845, Odont., p. 64, pl. 28, f. 1.
Callorynchus antarcticus Günt., 1870, Cat., **8**, p. 351 (part); Hect., 1901, Trans. and Proc. New Zeal. Inst., **34**, p. 239, pl. xiv, f. A. & B.
Callorynchus dasycaudatus Colenso, 1879, Trans. and Proc. New Zeal. Inst., **11**, p. 298, pl. xvii, fig. 1.
Callorynchus callorynchus Waite, 1907, Rec. Cant. Mus., **1**, p. 9.

Pectorals rather broad, hardly reaching to the bases of the ventrals. Origin of the first dorsal very little in advance of the origins of the pectorals. Origin of the second dorsal above the axils of the ventrals. Anal narrow, pointed, deeper than the produced lobe on the anterior end of the subcaudal; origin a little backward of the end of the base of the second dorsal. Caudal fins tapering, slender posteriorly; filament short or absent. Dorsal spine not reaching to the second dorsal by a considerable space. Lateral line with many short irregular bends below the space between the first dorsal and the caudal. Hinder margins of the ventrals concave. The tritors on the palatine laminae of the young are straight bars; later they become reduced in number by fusion into a U-shape. On larger specimens the anterior prongs of the tritor become more thickened, and are more nearly equal in length than in *C. callorynchus*. In

fact *C. milii* is very closely allied to *C. capensis*. A young individual of sixteen inches has the tritors separate posteriorly, but the space between them is very narrow; posteriorly they are much swollen though anteriorly slender and pointed.

Flanks silvery; a vertebral space and the top of the head brownish; a brownish blotch above the base of the pectoral and an indefinite brownish band below the silvery one along the course of the lateral line.

Australia, Tasmania, and New Zealand.

Callorynchus tritoris.

Callorynchus tritoris Garman, 1904, Chismopnea, Bull. M. C. Z., **41**, p. 271, pl. 6, f. 9.

The type of this species is a nearly complete skeleton. The tritors of the palatines are on the posterior half of the lamina and have changed so greatly from the ordinary form, of the U-shape, that they are broader than long and the prongs have almost completely disappeared. Vomerine and palatine dental laminae are illustrated by the figure mentioned above.

Mexillones, Peru.

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XL. No. 4.

SOME CHINESE VERTEBRATES.

INTRODUCTION . . By SAMUEL HENSHAW.
PISCES . . . . By SAMUEL GARMAN.
AMPHIBIA AND REPTILIA By THOMAS BARBOUR.
AVES . . . . By JOHN E. THAYER AND OUTRAM BANGS.
MAMMALIA . . . By GLOVER M. ALLEN.

WITH SIX PLATES.

CAMBRIDGE, U.S.A.:
Printed for the Museum.
August, 1912.

SOME CHINESE VERTEBRATES.

CONTENTS.

	Page
INTRODUCTION.— By Samuel Henshaw	107
PISCES.— By Samuel Garman	111
AMPHIBIA AND REPTILIA.— By Thomas Barbour	125
AVES.— By John E. Thayer and Outram Bangs	137
MAMMALIA.— By Glover M. Allen	201

INTRODUCTION.

By Samuel Henshaw.

The collections described in the following pages were made in the Chinese provinces of Hupeh and Szechwan during the years 1907 and 1908. With hardly an exception they represent the work of Mr. Walter R. Zappey while he was attached to the expedition sent out by the Arnold Arboretum, under the direction of Mr. E. H. Wilson, the well-known botanical collector.

Mr. John E. Thayer, recognizing the need of zoölogical work in lower China, secured the consent of Prof. C. S. Sargent, the Director of the Arnold Arboretum, for a trained collector to accompany Mr. Wilson, and most generously provided the necessary financial support. The obligations of the Museum to Mr. Thayer, already very great, were much increased by this recent act of liberality, and his selection of Mr. Zappey for the work was very fortunate. Mr. Zappey's zeal was such as to require a constant word of caution that he might not overtax his strength, while the size and condition of the entire series of specimens afford evidence alike of his judgment, his energy, his skill in preparation, and his care and watchfulness during the many difficulties in transportation. The results of Mr. Thayer's liberality and Mr. Zappey's zeal would have been very much less, however, had they not been supplemented by the tact and administrative ability of Mr. Wilson. Mr. Wilson's earlier work in China was of distinct advantage for the success of the Arboretum Expedition. It had shown that he possessed the trustworthiness characteristic of his race, and the natural and ever present suspiciousness of the natives towards aliens engaged in a line of work the object of which is not wholly clear, was happily avoided, from the beginning.

It should also be recognized that all of Mr. Wilson's time and energy were required for his botanical work [1] and that every additional task he assumed, even though willingly and successfully, was nevertheless a burden.

The transcription of Chinese geographic names presents difficulties of orthography, syllabication, and capitalization; in some works the same name is variously given. It is believed that throughout the following pages a considerable degree of uniformity has been achieved, a result due to Mr. E. C. Drew, who has

[1] Some of the results of Mr. Wilson's work in China have been published by the Arboretum:—Plantae Wilsonianae. Part I. Cambridge, July 31, 1911, 144 pp. Part II. Cambridge, April 30, 1912, 168 pp.

most kindly revised a list of the geographic names and corrected many puzzling variations due largely to phonetic spelling.

The larger part of the material secured consists of birds and mammals, though other interesting vertebrates were collected together with a small series of invertebrates, chiefly insects.

Messrs. Wilson and Zappey landed at Shanghai the 4th of February, 1907; while outfitting, Mr. Zappey employed his time in collecting in the immediate environs of Shanghai, but here, as in the vicinity of other large cities, the density of the population precluded effective collecting. Ichang, Hupeh, the base for much of the work of the Expedition was reached on the 26th of February, and after several weeks spent in its vicinity Mr. Zappey left that city early in April and collected for about two months among the mountains north of the Yangtze. Here at varying altitudes of from 2,400 to 9,500 feet in well forested country, pheasants were abundant and the probable occurrence of the Takin, (Budorcas), noted.

With the exception of two weeks passed unfortunately in the hospital at Hankow, Mr. Zappey collected during June, July, and August in the Ichang region or between Ichang and Shasi; much rain fell during this period and the weather when fair was very hot. September and October also proved rainy in and about Ichang.

Between the 5th and 20th of November, Mr. Zappey worked at higher altitudes at Shihtowya, Kwangpow, Putze, and neighboring places, good weather prevailing, but cold and cloudy days were experienced again at Ichang between the 21st of November and the 1st of December. December proved fair, with the temperature cool or cold, and a considerable series of birds and mammals was secured. The search for Serow among the mountains was unsuccessful, though their tracks were found on several occasions and the alarm note which Mr. Zappey describes as "a series of snorting squeals sounding like * * * tearing a piece of starched cloth such as a window shade" furnished additional evidence of their presence.

In 1908, January, February, and early March were spent in short trips down the river; on the 15th of January at Ichanghsien the first Goral, *Naemorhedus griseus*, was collected; others of both sexes, young and old, were taken later. These goat-like antelopes were not uncommon on the precipitous evergreen-clothed cliffs; they were seen, however, only in open places as they jumped from ledge to ledge and their capture was thus to a certain degree a matter of chance. Kwangtitze, situated about fifteen miles below Shasi, with an abundance of

grass cover and numerous reedy pools, proved an ideal country for deer; and here, early in February, water deer, *Hydrelaphus inermis*, were plentiful and a fine series was secured.

Returning to Ichang the 18th of February, the interval until the 13th of March was occupied, principally, in the care of material and in the preparation for a long river trip to the west.

Leaving Ichang the 13th of March the following list of localities with dates will indicate the route travelled:—

1908:	March	16	— Nantow.
		25	— Patunghsien.
	April	1	— Wanhsien.
1908:	April	4	— Changchowhsien.
		11	— Chungking.
		21	— Juchi.
		26	— Nanchihsien.
		30	— Suifu.
	May	6	— Kiating. The river-boat was left at this point.
		12	— Lungchi.
		15	— Washan.
	June	13	— Kiating.
		21	— Hungyahsien.
		29	— Nitow.
	July	4	— Tachienlu.
		14	— Yachiakun.
		18	— Lianghokow.
		24	— Cheto.
	August	5	— Tongolow.
		7	— Nachuka.
		15	— Ramala Pass.
		16	— Shuowlow. Farthest west.
1908:	August	26	— Nachuka.
		31	— Tachienlu.
	September	6	— Lianghokow.
		17	— Tachiao.
		23	— Tachienlu.
	October	9	— Yachow.
		17	— Omeihsien.
		22	— Washan.

November 9 — Tsaikow.
11 — Omeihsien.
15 — Chinchiang.
30 — Chiachianghsien.
December 3 — Yachow.
8 — Kiating. River-boat trip resumed.
23 — Suifu.
29 — Chungking.
1909: January 14 — Ichang.
22 — Hochiaping.
February 2 — Changyanghsien.
5 — Ichang.
March 7 — Shasi.
18 — Nankin.
26 — Leave Shanghai.

As shown by the above itinerary, the Expedition was planned as a reconnaissance and covered too much ground to allow successful intensive collecting. At five localities only were fifty or more species obtained; the largest number, 194, was taken at Ichang, and 91, the next in number, at Washan. This last locality proved of great scientific interest and ten of the thirty-six new forms discovered were found there. It was at Washan that a herd of Takins, *Budorcas tibetanus*, was observed. Two individuals, a young male and a young female, said by the natives to be about a month old, were taken. The herd was feeding on the side of the steep mountain at an elevation of about 10,000 feet and was well concealed in the dense bamboo thicket. The flesh of these Takin proved palatable and in taste resembled mutton. The native names for the Takin are *Yare niu ngai nu* and *Parn nyang*.

Serow, *Capricornis argyrochaetes*, were also found at Washan, where they frequented the recesses of the most precipitous cliffs. The native name of the Serow is *Ngailu* (Cliff donkey).

Though formerly abundant throughout the region traversed by Mr. Zappey, the Musk deer, *Moschus sifanicus*, has been so persistently hunted for the sake of its valuable secretion that it is now practically exterminated. One specimen was shot at Shuowlow the 19th of August, 1908. The odor from the scent-gland was most powerful though quite different, Mr. Zappey notes, from that of the refined perfume. The habit of this species of frequenting the trunks of fallen trees is well known to the Chinese.

PISCES.

By Samuel Garman.

The fishes, twenty-nine species, secured by this Expedition were taken at various points on the Yangtze Kiang and its affluent the Min, between Kiating and Shasi sixty miles or more below Ichang, Hupeh. Three of the species are Chinese perches, Siniperca, also said to be found in Japan; one is a clupeoid, Coilia, heretofore known as marine, the presence of which so far from the mouth of the river is probably due to a habit of spawning in fresh water; another is an Ophicephalus of wide range in eastern Asia; three others are siluroids, one of them very widely distributed, another peculiar to the locality, and a third apparently undescribed; twenty are cyprinoids which taken together might indicate rather less dependence on barbels in their region than farther to the south or to the west; three of these species appear to be undescribed; and finally one of the species is an eel, Monopterus, which has been taken in numerous localities of China, India, the East Indian Archipelago, and Japan. In early days the fishes of the valley of the Yangtze were more distinct, because more isolated, than at present. By means of the Grand Canal all streams of moderate length between Hangchow on the south and Pekin on the north were linked together so that the basin of the Hwang Ho, draining into the Gulf of Chihli, and that of the Yangtze Kiang drained into the Yellow Sea are no longer so far as concerns their fishes to be treated as distinct faunal regions. This connection by the Canal accounts for the fact that Basilewsky, 1855, has described so many of the species contained in the present series, from collections in great part made in streams flowing into the Gulf of Chihli, and also for the fact that his types and specimens from the Yangtze differ so little. The Chinese types described by Bleeker were mainly taken near the mouth of the Yangtze, as were those described by Steindachner and the earlier of those of Günther. By later contributions Sauvage, Günther, and Regan have added to the knowledge of the species much nearer the sources of the river. The localities traversed by Mr. Zappey were thus pretty well surrounded by the localities of earlier workers. In the following list additions to original descriptions and variations of individual specimens are recorded by the partial diagnoses appended.

SERRANIDAE.

Siniperca chua-tsi (Basilewsky) Gill.

A number of specimens of the Chinese perch that would usually be placed under *S. chua-tsi* separate readily into two groups:— one, the species proper, characterized by an eye about one sixth of the length of the head, or one and one half times the interorbital width, and on which the maxillary reaches beyond a vertical from the hind edge of the eye, and another in which the eye is nearly one fourth of the length of the head, or about twice the interorbital width and in which there is a considerable distance behind the end of the maxillary in front of a vertical at the hind border of the orbit. In the numbers of fin-rays or in markings the two groups show little difference, but the scales on the specimens with the small eyes appear to be smaller. The presence of the two forms in the same locality may be ascribed to individual variation in a single species, or may be credited to an intermixture of two quite distinct species at some time or in some parts of their respective ranges. The two figures published by Basilewsky, 1855, represent the small-eyed form. Kner, 1867, under the same name, figured a specimen, in which the eye is much larger and the maxillary approaches a vertical from the hind edge of the orbit, which might better be placed in the group with large eyes, though the type of the latter described below has a still larger eye and an orbit extending farther backward than the end of the maxillary. As the theory of a mixing of two forms originally distinct is favored here, the large-eyed one is described as *Siniperca knerii* and certain characters of the specimen chosen for a type are noted.

Ichang.

Siniperca knerii, sp. nov.

D. 12 + 14, A. 3 + 9, V. 6, P. 2 + 14; Ll. $125\frac{25}{70}$ ca.

Similar to *S. chua-tsi*, but differing in a much larger eye. Diameter of orbit five sixths of its distance from the extreme end of the snout, nearly twice the width of the interorbital space, or twice the greatest width of the maxillary, or equal to the distance from the orbit to the front of the intermaxillary. Maxillary subtending the anterior three fourths of the eye. Dorsal origin above that of the pectoral; spinous portion twice as long as the soft; spines increasing in length to the fifth, which is about one third of the length of the head, a little shorter than the soft rays, or than the second anal spine which last is the longest and most robust on the body. First and third anal spines shorter and

more slender than the second. Markings differing little from those of the small-eyed form.

Type:—No. 29844 M. C. Z. Hupeh: Ichang.

Siniperca scherzeri Steindachner.

Agrees closely with the figure by Steindachner, the most noticeable difference being in the larger size and greater number of the teeth on the posterior edge of the operculum.

Ichang.

OPHICEPHALIDAE.

Ophicephalus argus Cantor.

D. 48, A. 32; Ll. $63\frac{8}{18}$.

Kiating.

CLUPEIDAE.

Coilia nasus Schlegel.

D. 13, A. 98, P. 6 + 11; Ll. 76.

Ventral serration with twenty-two teeth in front of the ventral fins and thirty-six behind their origins. Intermediate between *C. nasus* and *C. ectenes* Jordan and Starks but not to be separated from the former.

Kiating.

CYPRINIDAE.

Cyprinus carpio Linné.

D. 22, A. 8, V. 9, p. 17; Ll. $35\frac{6}{5}$; Phar. teeth 3.1.2 | 2.1.3; 4 barbels.

Shasi.

Carassius carassius (Linné) Nilsson.

D. 20, A. 8, V. 9, P. 16; Ll. $29\frac{7}{6}$; Phar. teeth 3 | 3; no barbels.

Ichang.

Parabramis pekinensis (Basilewsky) Bleeker.

Abramis pekinensis Basil., 1855, Nouv. mem. Soc. nat. Mosc., **10**, p. 237, pl. 6, f. 2.
Acanthobrama pekinensis Bleeker, 1860, Ichth. Arch. Ind. Prodr., **2**, Cypr., p. 282.
Culter pekinensis Kner, 1867, Novara fische, p. 360, pl. 14, f. 4.
Chanodichthys pekinensis Günther, 1868, Cat., **7**, p. 327.
Parabramis pekinensis Bleeker, 1871, Nat. verh. k. akad., **12**, p. 80.

D. 3 + 7, A. 3 + 32, V. 9, P. 17; Ll. $53\frac{12}{7}$; Phar. teeth 5.4.2 | 2.4.4.

These specimens are not as dark on the body or fins as that figured by Basilewsky, but the scales have the light centres surrounded by puncticulations of brown. Distally each of the fins is darker. The general effect of the color is silver rather than brown. Body keeled from the pectorals backward to the end of the anal base. Dorsal origin midway from end of snout to base of caudal. Kner's figure does not represent the species very well, as it is too slender; the description is good. Basilewsky described the species from affluents of Chihli; Mr. Zappey secured it at Ichang.

Opsariichthys acutipinnis (Bleeker) Günther.

Barilius (Barilius) acutipinnis Bleeker, 1871, Nat. verh. k. akad., **12**, p. 81, pl. 13, f. 1.
Opsariichthys acutipinnis and *O. bidens* Günt., 1873, Ann. mag. nat. hist., ser. 4, **12**, p. 249.

The figure of *O. acutipinnis* was made from a half grown specimen. The description of *O. bidens* also was drawn from a specimen not fully developed. The specimens at hand make it evident that *O. bidens* is a synonym. The notches of the jaws are very evident on some and hardly noticeable on others. There is much variation in individuals aside from the peculiar sexual changes in the fins and the tubercles of the cheeks. The pharyngeal teeth vary from 4.2 to 4.3 and to 4.3.1. The difference in numbers of rays or of scales is not great. In the adult the markings on the fins and flanks are like those of *O. platypus*, but the interradial spots are more distinct, and on some the lower half of the face is blackish.

Kiating, Min River.

Garra (Ageneiogarra) imberba, subgen. nov. sp. nov.

D. 13 (4 + 9), A. 8, V. 10, p. 17; Ll. $50\frac{6}{4}$, head to D. 17; Phar. teeth 5.4.2 | 2.4.5, slender, pointed.

Body elongate, greatest depth about equal to length of head or one seventh of the total length, compressed posteriorly, depressed and broadened in front. Head wider than deep, flattened below, slightly convex, both longitudinally and transversely, on the top. Snout very wide, short, broadly rounded across the end. Eye moderate, less than one fourth as long as the head and behind its mid length, in width of orbit less than half the interocular space. Nostrils close together, nearer to the eye than to the end of the snout. Snout without a lobe above, as in *G. lamta*, but with a group of pits at each side of the middle

of the upper surface. Mouth large, inferior, outline somewhat arched transversely; upper lip fringed, connected at the angles with a fold passing a short distance behind that at the hind edge of the disk; jaws sharp-edged. The deep transverse groove in front of the disk, behind the lower jaws, is not continued at its sides. No barbels. Pectorals short, reaching more than half way to the ventrals. Middle of dorsal base half way from snout to base of caudal; fin as high as long, hind margin deeply indented. Ventrals shorter than the dorsal, but extending a little farther backward, origins below the eighth ray of the dorsal. Anal smaller than the ventrals, origin midway between the bases of the ventrals and the base of the caudal. Caudal deeply notched. Total length 10.5 inches.

Lower surfaces uniform yellowish; back darker yellow to brownish, each scale with a transverse darker streak on its forward portion, those on the lateral line a little more distinct.

The generic diagnosis of Garra being modified so as to include *G. imberba*, with Bleeker's subdivisions, based on the number of barbels, the subgenera Garra, with four barbels, Discognathus with two, and Ageneiogarra with no barbels, are readily distinguished.

Type:—No. 29835 M. C. Z. Western Szechuan: Kiating, Min River. W. R. Zappey.

Onychostoma laticeps Günther.

D. 4 + 8, A. 3 + 5, V. 9, P. 16; Ll. $49\frac{8}{5}$; Phar. teeth 5.3.2 | 2.3.5, slender, pointed.

Slight differences from the type are to be seen among these specimens. Head short, about one fifth of the length to the base of the caudal, moderately broad, blunt, arched from the snout to the eyes and across the interorbital region. Eye one fourth of the length of the head, in front of its mid length. No barbels. Mouth large, arched, reaching the sides of the head below the eyes; lower jaws very strong, with a slight knob below the symphysis; upper jaws thin and protrusive (downward); upper lip thin, distinct. Pectorals small, pointed, reaching a vertical from the origin of the dorsal. Dorsal with a strong serrated spine, the fourth ray longer than the head, hind margin of fin concave, angles acute, middle of base in the middle of the total length without the caudal. Ventral origin below the sixth dorsal ray, outer angle acute. Anal short, pointed, origin midway from the origins of the ventrals to the base of the caudal, third ray as long as the head. Caudal deeply notched, lobes

acute. Scales moderate, longitudinally with fine striations. Lateral line in the middle of the side of the tail. Largest specimen eleven inches.

Lustrous golden, darker on upper half of body and head; fins darker.

Originally described from Huisien.

Ichang.

Ctenopharygodon idellus (Valenciennes) Günther.

D. 10, A. 11, V. 9, P. 20; Ll. $43\frac{7}{5}$, 18 scales from head to dorsal; Phar. teeth 4.2 | 2.5.

Top and sides of head darkened by dots of black pigment; scales of back and flanks similarly darkened near the edges; fins dark on their edges, distally thickly dotted with black; lower surfaces uniform light.

Shasi.

Myloleuciscus atripinnis, gen. nov. sp. nov.

D. 10, A. 11, V. 9, P. 21; Ll. $42\frac{7}{5}$; 16 scales in front of the dorsal; Phar. teeth 5 | 5, in a single series.

Form resembling that of *Ctenopharygodon idellus*, elongate, compressed and rather deep in the caudal region. Head about one fourth and depth two ninths of the length from end of snout to base of caudal, a little deeper than broad posteriorly, pointed in front, subquadrangular in cross section; crown broad posteriorly, convex transversely. Eye large, length two ninths of that of the head; bones of the orbital series narrow, preorbital bone little longer than deep. Mouth moderate, somewhat oblique, width and length about equal; maxillary hardly reaching a vertical from the orbit; intermaxillary protractile. No barbels. Pharyngeal teeth in a single series of five, two of which are very broad, stout, rounded molars, the remaining three being longer, more slender, and compressed with crowns of a different shape and concave. Fins rather small. Pectorals reaching two thirds of the distance to the ventrals. Dorsal origin midway from end of snout to base of caudal. Ventral origin below the third ray of the dorsal, fin not reaching as far back as the dorsal. Anal origin midway from origins of ventrals to base of caudal. Caudal notch not half the length of the fin.

Body dark with puncticulations of black; fins blackish.

Type:— No. 29817 M. C. Z. Hupeh: Shasi. W. R. Zappey.

The genus Myloleuciscus may be characterized by a single series of pharyngeal teeth, some of which are extremely broad, short, rounded molars and

others are longer, more slender and compressed, and have oblique, concave, pointed crowns. It is probable that *Leuciscus aethiops* Basilewsky, 1855, belongs to this genus. Günther's use of that species as the type of his genus Myloleucus, 1873, will not interfere, since the name Myloleucus had been applied by Cope, 1871, to other species not congeneric. Myloleucus of Günther, 1873, was "characterized by extremely broad, molar-like pharyngeal teeth, in a single series."

Squaliobarbus curriculus (Richardson) Günther.

D. 10, A. 11, V. 9, P. 17; Ll. $45\frac{7}{3}$; Phar. teeth 5.3.2 | 2.3.4, compressed, pointed.

Dorsal origin midway from snout to base of caudal. Origins of the ventrals below the third ray of the dorsal. Anal origin midway from the axils of the ventrals to the base of the caudal. A minute barbel at the angle of the mouth.

Silvery; blackish on the bases of the scales of the flanks and the back, forming longitudinal vittae; silver-white under the edge of the opercle to the shoulders; fins dusky.

Ichang.

Squaliobarbus elongatus Kner.

D. 12, A. 12, V. 10, P. 19; Ll. $68–70\frac{10}{4}$, 30 scales from head to dorsal.

Mouth reaching to a vertical from the nostril, not to the anterior border of the eye. No barbels. Preorbital bone very large, close to the eye the nostrils and the mouth cleft; suborbitals narrow, elongate. Pharyngeal teeth 5.4.2 | 2.4.4, compressed and hooked. Peritoneum blackish, silvered. Origin of the dorsal halfway from the end of the snout to the base of the caudal, very little farther back than the origins of the ventrals. Scales lustrous silver; back darker, olivaceous. A close ally of *Squaliobarbus dahuricus* Basilewsky from Mongolia and Mantchuria but distinguished by fewer scales in the lateral line and by the position of the dorsal, nearer the head.

Ichang.

Xenocypris nitidus, sp. nov.

D. 3 + 7, A. 3 + 9, V. 9, P. 18; Ll. $60\frac{8-9}{5}$.

Body much compressed, not keeled below, depth, or length of head, about two ninths of the length, without the caudal. Eye large, two sevenths of the head, equal its distance from the end of the snout. Suborbital bones narrow,

elongate. Snout produced. Mouth inferior, transverse, bent backward at the preorbital bone. Pharyngeal teeth 6.4.2 | 2.4.6, larger compressed pointed and rigid, smaller slender and movable in the inner rows. Pectorals small, not reaching the ventrals. Ventral origins below the middle of the dorsal base. Third ray of the dorsal strong, as long as the head. Anal small, base twice as far from the bases of the ventrals as from the base of caudal. Dorsal origin a little forward of midway from end of snout to base of caudal, fourth ray in the mid length, spine as long as the head. Caudal deeply notched. Scales moderate.

Cheeks and scales silvery; upper half of body, and top of head brownish.

Intermediate between *X. tapeinosoma* Bleeker and *X. argentea* Günther. *Xenocypris nitidus* is more elongate and less oval than *X. lampertii* Popta; the eye is larger and about half its length is in the hinder half of the head, it is also about twice as far from the upper outline of the head as from the lower; there is no keel in front of the vent; there are more scales in the lateral line and fewer in the transverse; and the origin of the dorsal is farther forward.

Types:—No. 29822, 29823 M. C. Z. Hupeh: Shasi. W. R. Zappey.

Hemiculter leucisculus (Basilewsky) Bleeker.

D. 9, A. 16, V. 6, P. 15; Ll. $45\frac{7}{3}$, head to dorsal 19 scales.

Dorsal origin in the middle of the length from the end of the snout to the base of the caudal, at a vertical from the hind ends of the bases of the ventrals. Pectorals acuminate, ending in front of the origins of the ventrals at a distance greater than the length of the orbit.

The type of this species was taken in streams flowing into the Gulf of Chihli. The specimens in this collection were taken at Shasi on the Yangtze Kiang.

Among individual variations it is to be noticed that on some specimens the lateral line rises abruptly above the base of the anal, on four scales, then continues for eight scales in the middle of the caudal pedicel in a direct line; on others the rise is as gradual as that figured by Bleeker.

Culter dabryi Bleeker.

D. 3 + 7, A. 3 + 26, V. 9, P. 15; Ll. $64\frac{11-12}{5-6}$.

Depth equal four seventeenths of the length to the base of the caudal; head equal two ninths of the same length. Nape slightly convex. Abdominal

edge trenchant from the pectorals to the anal. Eye large, diameter nearly one sixth of the head; longer than the distance from the end of the snout. Mouth nearly vertical, maxillary reaching below the hinder nostril. Preorbital bone deeper than long; suborbitals narrow. Pharyngeal teeth 5.4.2 | 2.4.5, compressed, pointed, hooked at the apex. Dorsal origin half the length of the orbit behind the middle of the length from snout to base of caudal; third spine strong, as long as the head. Caudal pedicel longer than deep in the free portion. Lateral line curving downward on the flank and again up to the middle of the pedicel. Total length, six inches.

Silvery; back brownish or olive tinted.

Shasi.

Luciobrama typus Bleeker.

D. 10, A. 13, V. 10, P. 15; Ll. $150\frac{28}{12}$ ca.

Head long, pointed, scaleless, one fourth of the total length. Eye in the foremost third of the head. Mouth little longer than the eye; maxillary reaching nearly to the orbit. Dorsal origin in the middle of the length from the eye to the end of the caudal, about one length of the dorsal base farther back than the origin of the anal. Pectorals small. Pharyngeal teeth 5.1 | 1.5 nearly straight, slender, tapering to a point. Bleeker says of these teeth, "valde gracilibus insertis uniseriatis acicularibus vix curvatis 4 | 4," which indicates a considerable variation, with need of some change in the generic diagnosis. Caudal notch deep, lobes subequal. Bright silvery, somewhat darkened on the back.

Ichang.

Hemibarbus maculatus Bleeker.

D. 3 + 7, A. 3 + 6, V. 9, P. 20; Ll. $49\frac{7}{5}$.

Maxillary barbels half as long as the orbit. Orbit half as long as the snout, or two ninths of the length of the head. Pharyngeal teeth 5.4.2 | 2.4.5, pointed. Dorsal origin halfway from end of snout to base of caudal. Ventral origins below the fifth ray of the dorsal. Anal origin equidistant from ventral origins and base of caudal. About eight darker blotches on the second row above the lateral line, apparently under the scales; below these the scales are silvery, above they are darker and with dorsal and caudal fins somewhat maculate with dark.

Ichang.

Saurogobio dumerilii Bleeker.

D. 9, A. 9, V. 8, P. 16; Ll. $59\frac{7}{3}$.

A prominence below the symphysis of the lower jaws. Barbel reaching below the middle of the eye. Pharyngeal teeth 5 | 5; two of these teeth, in each series, are molar-like, resembling those of *Myloleuciscus atripinnis* but not so much differentiated. Dorsal origin at one third of the distance from the end of the snout to the base of the caudal, and anal origin in the hindmost fourth of this length. End of dorsal and ends of ventrals opposed. Pectorals reaching a vertical from the origin of the dorsal. Scales of the lateral line and below plain golden; three of the vertebral rows with brown hind margins, three other rows at each side of the dorsal three with a brown spot on the middle of the hinder edge of each scale, forming longitudinal vittae. Bases of fins yellow, distal portions darker. Total length $10\frac{1}{2}$ inches.

Ichang, Shasi.

Coripareius, gen. nov.

Body compressed, deep in the caudal pedicel, dorsal and ventrals in the forward half; head tapering, entirely covered by thick skin; snout produced, blunt. Mouth narrow, inferior, lips thick. Maxillary barbels present. Pharyngeal teeth 5 | 5 or 4, compressed with large crown. Scales moderate, lateral line straight, in the middle of the tail. Dorsal small, without osseous ray, above the ventrals. Anal short.

Type. *C. cetopsis* (Kner).

Coripareius cetopsis Kner.

?Gobio heterodon Bleeker, 1864, Ned. tijd., **2**, p. 26.
Labeo cetopsis Kner, 1867, Novara fische, p. 351, pl. 15, f. 2.
Barbus cetopsis Günther, 1868, Cat., **7**, p. 135.
Saurogobio cetopsis Bleeker, 1871, Nat. verh. k. akad., **12**, p. 8.

D. 9, A. 9, V. 8, P. 19; Ll. $54\frac{7}{6}$.

The body is rather narrow, depth, or length of head, about one fifth of the total. Head posteriorly as wide as deep, tapering forward, prominent and bluntly rounded at the end of the narrow snout. Nostrils large, close together, near the eye. Eye small, one eighth or less of the head, with a comparatively wide adipose ring. Mouth as wide as long, cleft broadly rounded in front or subtruncate. Lips thick. Barbels two, reaching the hind edge of the preopercle. Entire head, including the opercles covered with loose thick skin.

Pharyngeal teeth 5 | 5 or 4, compressed with expanded crown. All fins acuminate. Pectorals reaching the origins of the ventrals, or a vertical from the fifth ray of the dorsal. Dorsal short, without an osseous ray, entirely in the anterior half of the total length, hardly reaching the mid length when depressed; height equal length of head. Ventrals short; origins below the third dorsal ray. Anal small; origin equidistant from that of caudal and origins of ventrals. Caudal deeply notched, lobes pointed, upper longer. Lateral line on middle of flank and tail, straight. Scales moderate.

Lustrous golden, more olive on back and head; each fin with a blackish area in the distal half, tipped with white behind the black.

Luchow, Ichang, Shanghai.

Rhinogobio typus Bleeker.

D. 10, A. 9, V. 8, P. 16; Ll. $47\frac{8}{5}$.

Maxillary barbel reaching behind the middle of the eye. Length of orbit half of its distance from the end of the snout. Pharyngeal teeth in two series 5. 2 | 2.5, crowns hooked at the apex. Origins of pectorals below the fourth ray of the dorsal, fins extending to the origins of the ventrals. Ninth ray of the dorsal in the middle of the length from the snout to the base of the caudal; third ray shorter than the head. Anal origin about midway from ventral origins to base of caudal. Caudal deeply notched, lobes sharp; caudal pedicel elongate, not deep.

Ichang.

Pseudogobio filifer, sp. nov.

D. 10, A. 9, V. 8, P. 13–14; Ll. 42–$44\frac{5}{3}$.

Body elongate, slender, depth about one seventh and head one fifth of the total length. Eye moderate, one fifth of the head, nearly two thirds as long as the snout. Snout one third of the head length. Mouth not reaching a vertical from the eye; upper jaws the longer. Maxillary barbels extending farther back than the eye. Dorsal origin above the origins of the ventrals. Outer angles of pectorals and ventrals thread-like, second ray longest. Pectorals reaching behind the bases of the ventrals. Ventrals reaching nearly as far back as the end of the dorsal. Anal origin about midway from origins of ventrals to base of caudal. Caudal deeply notched, lobes acuminate. Middle of dorsal base equidistant from end of snout and base of caudal. Scales large; lateral

line descending little on the flank, ending on the middle of the tail. Form more slender than that of *P. rivularis*, as figured by Steindachner; back less high, dorsal lower; pectorals and ventrals much more produced; colors somewhat similar, but having a lateral band of silver with faint darker cloudings.

Lustrous silvery below the lateral lines; above the lines darker, blotched, and clouded faintly with brown. Fins, dorsal and caudal, with several oblique rows of small spots of darker brown parallel with the hind borders of the fins and not as in *P. sinensis* Kner.

Types:— No. 29833, 29834 M. C. Z. Hupeh: Changyanghsien, Yangtze Kiang River. W. R. Zappey.

Botia variegata Günther.

D. 12, A. 8, V. 10, P. 15; Ll. $215\frac{55}{60}$; total length 15 inches.

Body compressed, depth nearly one seventh of the total length. Head compressed, little less than one fourth of the total, greatest width about two fifths of the length. Snout narrower than deep, high and broadly rounded at the end. Eye small, hardly one twelfth of the length of the head. Suborbital spine strong, rather slender pointed, not bifid. Barbels six; the maxillary applied to the side of the head reach the end of the snout. Mouth moderate, as wide as long; cleft subtruncate in front; upper jaws with a prominence on the symphysis. Cheek with small scales in front of the operculum backward from the mouth. Pectorals and ventrals with a membranous fold in the axils. Dorsal origin equidistant from eye and base of caudal. Ventral origins below the third ray of the dorsal. Anal origin halfway from the origins of the ventrals to the base of the caudal. Dorsal, pectorals, and anal slightly concave on the hind margin; ventrals little convex. Caudal deeply notched. Outer angles of all fins acute. Depth of caudal pedicel two fifths of its length.

Brownish; head with narrow vermiculations and spots of bluish; each fin with about four oblique irregular and broken bands of brown; body with about six broad transverse bands of dark brown; the first and narrowest behind the gill opening, the second between pectorals and dorsal, the third on the origins of the ventrals, the fourth at the end of the dorsal base, the fifth above the anal, and the sixth, as long as deep, on the base of the caudal.

The specimen described shows some variations from the type, though both were from the same locality.

Ichang.

SILURIDAE.

Silurus asotus Linné.

Ichang.

Pseudobagrus vachellii Richardson.

Luchow, Ichang.

Liocassis naso, sp. nov.

D. 2 + 7, A. 16, V. 6, P. 1 + 11.

Depth of body one sixth, and length of head one fifth of the total length. Head about as broad as high at the occiput, narrowing forward, and from below to the crown. Crown straight from the nape to end of snout. Snout produced, subtruncate, and curving upward and forward from the mouth; not depressed and thin as in species of Macrones, little wider than deep at the end. No labial teeth; palatal teeth in a transverse band narrowly divided in the middle. Eyes lateral covered by skin, folds rudimentary, above and below. Barbels eight; maxillary slender, not reaching the gill opening, narial reaching the middle of the eye. Nostrils separated; anterior in front of the snout; posterior near the eyes, with a slender barbel in front. Skull covered by thin skin, with a minute spine on each of the ridges above the snout. Denticles of the dorsal spine weaker than those of the inner side of the pectoral spines. Caudal deeply notched. Adipose fin shorter than the head.

Brownish, with clouded areas at the top of the head, at the sides of the dorsal and behind it.

Type:—No. 29847 M. C. Z. Hupeh: Ichang. W. R. Zappey.

SYMBRANCHIDAE.

Monopterus javanensis Lacépède.

Muraena alba Zuiew, 1793.
Monopterus javanensis Lacépède, 1800.

The arrangement of the colors on this eel is suggestive that the back and upper surfaces are exposed to the more direct rays of light; these portions of the body are dark while the lower half is much lighter and even white. Further, the chin and throat are much darker than the balance of the lower surfaces, which is probably due to the habitual carriage of head and neck raised above the horizontal.

Washan; from a marsh near the Tung River, at an altitude of 6,000 feet or more.

AMPHIBIA AND REPTILIA.

By Thomas Barbour.

The collection embraces twenty-three species. For the most part they are long known and wide-ranging forms. Three species, *Hyla monticola*, *Amblycephalus chinensis*, and *Agkistrodon tibetanus*, are described as new.

The geographical ranges of several species have been extended by the material in hand; and one species, *Batrachypterus sinensis* Boulenger, is interesting because of its rarity.

So few collections have been made in the higher regions of the Szechwan-Tibetan mountain area that even so small a series is of peculiar interest in that it affords another addition to our knowledge of a region which has doubtless been the centre of dispersal for very many different forms.

AMPHIBIA.

CRYPTOBRANCHIDAE.

Megalobatrachus japonicus (Temminck).

Temminck, Fauna Japon., 1837, pt. 3, Coup d'oeil, p. xxvi (fide Stejneger).
Stejneger, Bull. 58, U. S. N. M., 1907, p. 6–11.

Stejneger says that he has no means of verifying the fact that Boulenger regards *Sieboldia davidiana* Blanchard from China as identical with Japanese specimens. That Boulenger, as was expected, as well as Krefft and Gray were correct in this stand is proven by material now in hand. Mr. Zappey took a fine example about two feet long at Yachow, and a young one at Hungyahsien both towns in western Szechwan. They are not distinguishable from Japanese specimens.

Stejneger (*loc. cit.*, p. 7) notes the three records of Blanchard, Krefft, and Gray from China. Other specimens are, one taken by Mr. A. E. Pratt at Kiatingfu, Szechwan, which Günther called *Megalobatrachus maximus*, a synonym of *japonicus*. Walterstorff (Abh. Mus. f. natur. u. heimkunde Magdeburg, 1906, 1, 2, p. 123) records two young examples obtained from native sources somewhere in the country back of Canton, collection of Dr. Martin

Kreyenberg. Walterstorff adds (p. 132) "Sonst in China von Muping, West-Sze-Tschuan, bekannt."

Probably the species will prove widely distributed in China from the Yangtze southward.

AMBLYSTOMATIDAE.

Batrachypterus sinensis (Sauvage).

Plate 1, Fig. 1.

Sauvage, Bull. Soc. philom. ser. 7, 1, p. 117.
Boulenger, Cat. Batr. Grad., 1882, p. 37.

It is a pleasure to record the capture of this rare form at Lianghokow, western Szechwan, at an altitude of over 12,000 feet. Mr. Zappey tells me that the single example taken was walking over a bed of damp moss among the stunted spruces and firs at the very limit of tree growth. There was no pond or stream of running water near by. It varies considerably from Boulenger's description in that the tail is little compressed and shows much less fin than his figure does; the digits are somewhat more slender; and the coloration is slightly different. The most important difference, however, is that the palatine teeth, instead of being "in two short transverse arched series between the choanae," are in two straight series slanting sharply and converging slightly anterior to the choanae; but still with a wide interspace, as Boulenger describes. Altogether while a series might prove that this form is specifically distinct, it seems more likely that the differences are due to individual variation, which in such characters as length of digits, for instance, so often shows such marked differences in these lowly forms.

BUFONIDAE.

Bufo bufo gargarizans (Cantor).

Cantor, Ann. mag. nat. hist., 1842, 9, p. 483.
Stejneger, Bull. 58, U. S. N. M., 1907, p. 68.

Mr. Zappey took nine toads about Ichang. These have been referred with a certain hesitation to Cantor's subspecies as Stejneger defined its range. Unfortunately we have no Russian, Turkestan, or Upper Chinese material available for comparison. The specimens vary greatly in the distinctness of the tympanum, which is easily seen, and is half as large as the eye in some, while in

others it can be made out only by close scrutiny. The back of some, as well as the sides and thighs, are covered with large round tubercles, while in one the back has only scattered spine-bearing warts. In some the second finger is considerably longer than the first while in others they are of about equal size. In one the parotid gland has a tendency toward a crescentic shape, while in another it is simply elongate. The amount of black both above and below varies extremely.

HYLIDAE.

Hyla arborea immaculata Boettger.

Boettger, Ber. Senck. naturf. ges., 1888, Abh., p. 189.
Stejneger, Bull. 58, U. S. N. M., 1907, p. 82–84.

Two specimens agree perfectly with the description of this subspecies, except that there is a web between the outer fingers. Unfortunately the locality tags are missing, and it is impossible to state whether they came from about Ichang or from Szechwan. Stejneger has covered the question of the identity of the various east Asiastic tree toads so completely that there is no need of further remarks on the subject. The Chinese and Japanese specimens in the M. C. Z. collection substantiate his conclusions.

Hyla monticola, sp. nov.

Plate 1, Fig. 2.

Type:— No. 2553 M. C. Z. Washan, western Szechwan, China. Altitude 10,500 feet. One adult specimen. W. R. Zappey.

Very distinct from *Hyla annectans* Boulenger and *Hyla chinensis* Günther with specimens of which it has been compared.

Vomerine teeth in two elongate series, well separated, converging backward, beginning between the middle of the extremely small choanae and extending considerably posterior to them. Tongue large and long, deeply nicked behind. Nostrils midway between eye and tip of snout, their distance from each other much greater than their distance from the labial margin. Interorbital space much greater than width of upper eyelid. Tympanum almost circular, its diameter less than half that of eye. Fingers distinctly webbed at base, slender, terminating in very small disks. Feet with rather slightly developed webs, tarsometatarsal joint, reaching tip of snout. Toes long, disks

slightly larger than those of fingers. Subarticular tubercles very weak; a weak inner and no outer metatarsal tubercle. Skin above smooth, below smooth on chest, but granular on throat and strongly granular on belly. An external vocal sac in male. Color *in alcohol*:— blue above with ocelli of dark brown, their centres brick-red. Throat dusky gray. Belly and inner side of limbs white, with many dark spots.

Color *in life*:— "green above, with ocelli of brown, with reddish centres. Inner side of thighs buff. Lower surfaces chrome-yellow" (W. R. Zappey).

The surmise from its structure that this was a ground-inhabiting form was confirmed by Mr. Zappey, who tells me that it was taken above tree line among low bushes and grass about two feet high.

RANIDAE.

Rana tigerina Daudin.

Daudin, Hist. nat. rain., 1803, fol. ed., p. 42; quarto ed., pt. 20, p. 64; Hist. nat. rept., 1803, **8**, p. 125. Stejneger, Bull. 58, U. S. N. M., 1907, p. 139–142.

The forty-four specimens of this common and wide-ranging frog show no appreciable difference from specimens taken in India and Burma. As Bengal was the type locality for the species, this fixes beyond doubt the identity of the Chinese individuals. Stejneger states that Formosan specimens agree with Chinese from Hong Kong. Van Kampen (Max Weber's Zool. ergeb., 1907, **4**, 2, p. 388, pl. 16, fig. C.) has separated examples from Celebes under the name of *R. t. angustopalmata*. This is probably a distinct species. The Bornean species is *Rana schlueteri* Werner. Specimens from Java show other differences, as do also those from the Malay peninsula; and those from the Philippines are recognizable as *Rana vittigera* Weigmann.

Though of high interest and importance a complete study of this species is impossible owing to the lack of adults from the various localities. They are extremely shy. In this Ichang series not one is fully adult. I have taken specimens throughout the range of the species but have adults from Java only. The Museum has some from India.

Rana nigromaculata Hallowell.

Hallowell, Proc. Acad. nat. sci. Phila., 1860, p. 500.
Stejneger, Bull. 58, U. S. N. M., 1907, p. 94–100.

Two specimens from Ichang show a slight variation from specimens from Pekin, in that the vomerine teeth-groups are rather less prominent and slightly nearer each other. Externally the two lots agree. One of Mr. Zappey's two examples shows an interesting abnormality. On the left-hand side the tympanum is wanting and the left vomerine tooth group as well. The opposite side shows a perfectly normal condition.

Rana plancyi Lataste.

Lataste, Bull. Soc. zool. France, 1880, **5**, p. 64.
Stejneger, Bull. 58, U. S. N. M. 1907, p. 101–102.

Six frogs taken at Ichang belong to this species. Dr. Stejneger very kindly identified them for me, and from his account (*loc. cit.*) we find previous locality records as follows:— Peking (type locality), Shanghai, Chusan, Ningpo, and Formosa. These six specimens taken by Mr. Zappey extend the range of the species very greatly.

REPTILIA.

NATRICIDAE.

Ptyas mucosus (Linné).

Linné, Syst. nat., ed. 10, 1758, **1**, p. 226.
Stejneger, Bull. 58, U. S. N. M., 1907, p. 345–347.

A single specimen from Ichang, about five feet long. Scale rows 17; ventrals 196, subcaudals 100, anal divided. There are 8 supralabials, and numbers four and five enter the eye. The three middle rows of scales are not keeled. There is but one loreal.

Widely distributed over all southeastern continental Asia.

Elaphe taeniurus Cope.

Cope, Proc. Acad. nat. sci. Phila., 1860, p. 565.
Boulenger, Cat. snakes Brit. mus., 1894, **2**, p. 47.
Stejneger, Bull. 58, U. S. N. M., 1907, p. 319.

The record of this wide ranging form from 10,300 feet at Laolingkung near the Tibetan frontier of western Szechwan is interesting as giving a clew to the

extent of its vertical distribution in China. The scale formula of 23 rows, 230 ventrals, and 104 subcaudals is typical. Two other specimens without data are from either Hupeh or Szechwan.

Stejneger says, "Ranging from Darjeeling in the west to Formosa and the Amur Province in the east, this species has the regular Himalayo-Chinese distribution."

Dinodon rufozonatum (Cantor).

Cantor, Zoöl. Chusan, 1840, pl. 11; Ann. mag. nat. hist., 1842, **9**, p. 483.
Boulenger, Cat. snakes Brit. mus., 1893, **1**, p. 361–362.
Stejneger, Bull. 58, U. S. N. M., 1907, p. 358–363.

A specimen in every respect typical, from Ichang, Hupeh. This species is a common one ranging throughout China and Korea.

Liopeltis major (Günther).

Günther, Cat. coll. snakes Brit. mus., 1858, p. 120.
Boulenger, Cat. snakes Brit. mus., 1894, **2**, p. 279.
Stejneger, Bull. 58, U. S. N. M., 1907, p. 338–340.

A single typical specimen increases considerably the known range of this species. Stejneger speaks of it as "apparently restricted to the lower Yangtse Valley and coasts of eastern China, between Hongkong and Shanghai, as well as to Formosa." The example in hand, however, comes from "eight days' journey northwest of Ichang, Hupeh." It has been compared with a specimen from Formosa, in this Museum (T. Barbour coll.), and found to be almost identical. In both specimens the rostral shield is divided.

Natrix annularis (Hallowell).

Hallowell, Proc. Acad. nat. sci. Phila., 1856, p. 151.
Boulenger, Cat. snakes Brit. mus., 1893, **1**, p. 233.

A single specimen from Ichang whence the species does not appear to have been previously recorded. A. E. Pratt reported the species common about Kiukiang much lower down the Yangtze. The species ranges over middle China and Formosa. The specimen shows only 139 ventrals, while Boulenger notes a range of from 145 to 161. Another difference is the three postoculars in addition to the subocular on one side; on the other side the normal condition of 2 + 1 obtains. Again on one side the loreal is deeper than broad, while the normal opposite is found on the other side. The outer row of scales is without keel, as are also a considerable number in the second row. The tem-

porals are normal 2 + 3 on both sides. There is but one preocular and nine supralabials on each side; of these 4 and 5 enter the orbit. The scales are in 19 rows, anal is divided, ventrals, as already mentioned, 139, while part of the tail has been lost, only 54 pairs of subcaudals remaining.

Pseudoxenodon sinensis Boulenger.

Boulenger, Ann. mag. nat. hist., 1904, ser. 7, **13**, p. 134.

This form, which Boulenger remarks is so very nearly related to *P. macrops* (Blyth), is nevertheless a distinct and easily distinguishable one. As it was reported by the describer from both Yünnan and Szechwan, it is not surprising to find a typical example from Laolingkung, western Szechwan at an altitude of 10,300 feet. Not long ago I was fortunate enough to get a specimen taken at Yünnanfu by Mr. Graham at 6,000 feet altitude. Boulenger's Yünnan records were based on specimens taken by the same collector in the same locality. Both of these examples come within the range of variation which Boulenger cites for the five previously published specimens.

So far as known the species is confined to Szechwan and Yünnan.

ELAPIDAE.

Bungarus caeruleus multicinctus (Blyth).

Blyth, Journ. Asiat. soc. Bengal, 1861, **29**, p. 98.
Boulenger, Cat. snakes Brit. mus., 1896, **3**, p. 369.
Stejneger, Bull. 58, U. S. N. M., 1907, p. 397–399.

Dr. Stejneger (*loc. cit.*) has treated this form as one which he must consider nominally of specific value until it can be actually shown to join the Indian Krait *B. caeruleus*. The differences, however, are of such slight value that they do not warrant more than subspecific rank, even though our present insufficient material does not permit of our showing now the intergrading with not only the typical race, but also with the considerably more distinct Malaysian form, *B. candidus*.

This race, which is distributed through southern China from "The mountains north of Kiu-kiang" on the Yangtze-kiang to Kwangtung, Kwangsi, and the islands of Hainan and Formosa. Mr. Zappey's example from Ichang, Hupeh seems the first taken in that province and extends considerably the hitherto known range into western China.

AMBLYCEPHALIDAE.

Amblycephalus chinensis, sp. nov.

Plate 2, Fig. 1.

Type:— No. 7326 M. C. Z. Luluping, western Szechwan, China. W. R. Zappey.

Closely related to *A. monticola* (Cantor) from the eastern Himalayas, Khasi and Naga hills, and the Nocobar Islands.

Rostral not quite as deep as broad; internasals not half as long as prefrontals; latter entering orbit; frontal slightly longer than broad, longer than its distance from the end of the snout, much shorter than the parietals; loreal present but excluded from and entering orbit by two rather small preoculars; two postoculars, which on one side are fused into one; temporals 2 + 3; seven upper labials of which the fourth barely enters the orbit on one side, while on the other all are excluded by the extended inferior prefrontals and postfrontals; three pairs of large chin shields, anterior longer than broad and in contact with the symphyrial. Scales in 15 rows, smooth; three rows of vertebrals slightly enlarged. Ventrals 180; anal entire; subcaudals 60.

Color:— brown above, with vertical blackish bars on the sides; a black line from eye extending along nape, which is connected with its fellow on the opposite side by a black line which curves forward so as to almost touch the parietals; another black line from the eye to the angle of the mouth; yellowish below with very scattered dots of blackish brown.

Although there can be no doubt as to the very great similarity of this species with Cantor's *A. monticola*, yet it may be easily distinguished by the fact that the loreal does not enter the eye; nor does more than one labial. The very slightly enlarged vertebrals have no tendency toward becoming hexagonal, and there are rather fewer of both ventral and subcaudal scales in the type specimen than the least number recorded for Cantor's species. It shows relationship also with *A. malaccanus* (Peters), which, however, has no preocular.

CROTALIDAE.

Agkistrodon blomhoffii brevicaudus Stejneger.

Plate 2, Fig. 2.

Stejneger, Bull. 58, U. S. N. M., 1907, p. 463–464.

To this recently described subspecies three specimens taken by Mr. Zappey may be assigned. Two are from Ichang, from whence specimens have been recorded from the collection of the British museum (Stejneger, *loc. cit.*, p. 454). The scales run 21 rows; 145 ventrals, 39 subcaudals, and 7 labials for one, the other is mutilated. The third specimen comes from Kweichowhsien, Hupeh. Scales in 21 rows; 141 ventrals; 35 subcaudals, and 7 labials.

Occurs in Korea, eastern and part of central and of western China, Formosa, and possibly Hainan.

Agkistrodon tibetanus, sp. nov.

Plate 2, Fig. 3, 4.

Type:—No. 7327 M. C. Z. Ramala Pass beyond Tachienlu, western Szechwan: altitude 13,000 feet. W. R. Zappey.

Rostral as high as broad, scarcely visible from above; internasals large, roughly triangular, their suture almost as long as that of prefrontals, which are broadly in contact with supraoculars; frontal longer than broad, as long as the distance from rostral supraoculars, as long as frontal but narrower; parietals considerably longer than supraoculars; nostril round in the posterior part of the anterior nasal, which is slightly larger than the posterior; two loreals, one above the other, the lower one bordering the pit anteriorly; a narrow subfoveal enters the orbit with two preoculars, one of which also borders the pit posteriorly; pit very near eye, in fact meeting the orbit; two postoculars, of which the lower is long, narrow, and concentric, reaching far under the eye, but not approaching the scales behind the pit, as in *A. blomhoffii*; 2 + 4 temporals, of which the lower ones in each row are large hexagonal shields, those above being small scales (none keeled as in *A. blomhoffii*); the lower temporal of the third row large and shaped like those in front of it; the three lower temporals forming a series of large shields, larger than the adjoining labials; seven upper labials, second smallest, third and fourth very large, the rest gradually diminishing in size posteriorly; the third enters the eye for its entire superior margin, chin shields as in Stejneger's figure of the ventral view of head of *A. blomhoffii* (Bull. 58, U. S. N. M., 1907, p. 458, fig. 364); twenty-one rows of keeled scales, usually with indistinct apical pits; 152 ventrals; anal entire; 43 subcaudals, all divided.

The color is worthy of somewhat extended notice. The whole back is dull green with rhombic darker markings. Lower surfaces mottled black and dark grayish. Lower row of scales with light spots which alternate with light spots

on the extremities of the ventrals; between these two series of spots runs a zigzag black continuous band. On top of the head there is a dark blotch running from the edge of the frontal to a band from eye along neck. A rough horseshoe-shaped mark on the nape of the neck with the bow directed forward. The figures of this example compared with one of *A. b. brevicaudus* Stejneger show how radical is the difference in type of marking between the two forms, as well as the other divergences.

When showing the type of this species to Dr. Stejneger, he at once confirmed my decision to describe it as new, and remarked that he did not believe it to be very nearly related to any of the described forms, but to represent a species by far the most primitive of any in the genus. This is, of course, exactly what one might suppose would be the case with a form coming from the habitat of *A. tibetanus*.

AGAMIDAE.

Japalura yunnanensis Anderson.

Anderson, Zool. W. Yunnan, 1878, p. 803, pl. 66, fig. 2.
Boulenger, Cat. lizards Brit. mus., 1885, **1**, p. 310.

Five specimens taken among Cacti on the sandy shores of the Tung River in western Szechwan. These show no essential differences from Anderson's figure except that in none of these examples, and one is an adult male, do the spines of the weak nuchal crest reach the length which his figure shows. For in that three or four spines on the nape have a length almost equalling the diameter of the orbit, in none of these is the length one third as great. The types came from Momein or Tengyuehchow in western Yünnan. Swinhoe has collected the species in Szechwan.

SCINCIDAE.

Eumeces xanthi Günther.

Günther, Ann. mag. nat. hist., 1889, ser. 6, **4**, p. 220.

A single specimen from Ichang, the type locality and the only one from whence the species has been reported, differs somewhat from the original description. There is only one loreal, which, however, forms a suture with the fronto-nasals. There is also only one pair of nuchals. The second azygos postmental is separated from the first by the meeting on the median line of a pair of large

gular shields. There are five light longitudinal stripes on the back and sides. The central one bifurcates on the head, and the resultants meet the laterodorsal bands at the anterior margin of the eye.

Leiolepisma laterale (Say).

Say, Long's exped. Rocky Mts., 1823, **2**, p. 324.
Boulenger, Cat. lizards Brit. mus., 1887, **3**, p. 264.
Stejneger, Bull. 58, U. S. N. M., 1907, p. 218.

Careful comparison of a specimen taken by Mr. Zappey at Washan, western Szechwan, at 6,000 feet altitude, and another which the writer obtained, collected by Mr. John Graham at Yünnanfu at the same altitude, with North American examples, has forced the same conclusion previously reached by Boulenger and Stejneger as to the identity of specimens from both continents. Among a number of examples in the collection of the M. C. Z. from Florida, Texas, and Arkansas, individuals may be picked out which can not be separated from the two Chinese examples mentioned. Thus *L. reevesii* (Gray) becomes a synonym of *L. laterale* (Say).

This most remarkable distribution embraces the southeastern United States west to the Rockies, and including Mexico (Jalapa, example in British Museum), as well as almost all of southern and central China and the Riu Kiu Islands.

TRIONYCHIDAE.

Amyda sinensis (Wiegmann).

Wiegmann, Nova acta Acad. Leop. Carol., 1834, **17**, p. 189.
Stejneger, Bull. 58, U. S. N. M., 1907, p. 524–526.

A specimen from Chungking, Szechwan, which I have compared with examples in the collection of the U. S. N. M. from other localities, does not differ appreciably from specimens from Honan and Formosa, nor yet from Japanese examples, so that it adds evidence in support of Stejneger (Proc. U. S. N. M. 1910, **38**, p. 114).

TESTUDINIDAE.

Geoclemys reevesii (Gray).

Gray, Synopsis rept., 1831, p. 73.
Stejneger, Bull. 58, U. S. N. M., 1907, p. 497–500.

Eleven specimens from Ichang.

Stejneger says: "In China it is known from Tientsin to Canton, and in the interior at least as far as Hankow." It occurs also in Cochin China, Korea, and Japan. It will be noticed that the capture of these Ichang specimens extends the range for some distance up the Yangtze beyond Hankow.

AVES.

By John E. Thayer and Outram Bangs.

This collection of birds numbers 3,135 beautifully prepared skins, belonging to 358 species and subspecies. Considering the work that has been done in this region during the last forty years the collection is rich in novelties. In a preliminary paper — Descriptions of new birds from central China. Bull. M. C. Z., 1909, 52, p. 139–141,— we have already described eight new forms, and now add one new genus, five new species, and seven new subspecies.

When Mr. Zappey started it was expected that a Chinaman, perhaps one of the "shooting-men" trained by Mr. Styan, could aid in the collection and preparation of skins, but unfortunately none was available and Mr. Zappey did all the work himself, and deserves the greatest praise for his industry and zeal.

Specimens of nearly all the species seen were secured. Swans, cranes, and storks were now and then observed but were too shy to be shot with a gun, and were most frequently in places where it was too dangerous to use a rifle. The Solitary snipe, *Gallinago solitaria*, was seen on two occasions, one being shot near Ichang the first year, but its condition was such that it could not be preserved, and another flushed in the high grass lands of western Szechwan when with a rifle Mr. Zappey was stalking sheep. Another bird, a green pigeon, was seen twice, but was not taken. A flock of six or eight of these were feeding in the low shrubbery at a great altitude in the mountains of western Szechwan. They were very tame, but when approached to within gun-shot distance they were obscured by clouds and when the weather cleared the birds had disappeared. The second flock was seen by Mr. Wilson near the same place but when he was without a gun.

Time did not allow a visit to the Moupin district so famous, ornithologically, from the work done there by Père David, while the high mountains about Tachienlu, also a very famous region for birds, proved a great disappointment. The Chinese as they have gradually wrested this country from the Zolo tribesmen have burned the woods, reducing to ashes hundreds of miles of magnificent coniferous forest. This probably accounts for the absence in this collection of several of the species described from this region by Père David, Oustalet, and others. Of the places visited, one, the Washan mountains, needs special men-

tion. This high isolated range proved the richest field explored during the whole trip, and most of the peculiar birds and mammals secured came from it. It is to be regretted that so short a time, a few days in the spring and again a few in autumn, could be spent there.

All the altitudes were taken by Mr. Zappey himself with an aneroid.

We have followed the systematic sequence of Sharpe's Hand list, but our use of the 10th edition of Linné's Systema will account for the difference in many of the names employed. All measurements are in millimeters and the colors according to Ridgway's nomenclature.

We have compared many of our specimens with material in the U. S. national museum, and have received the constant aid and advice of Dr. Chas. W. Richmond and Mr. Harry C. Oberholser to whom our sincere thanks are tendered.

TETRAONIDAE.

Tetrastes severtzovi Prjevalsky.

Three specimens were taken in western Szechwan, an adult male, at Tachienlu, 13,500 feet, July 9, 1907, an adult female and a young female about half grown at Shuowlow, 14,000 feet, August 19, 1908.

PHASIANIDAE.

Tetraophasis szechenyii Madarász.

Seven specimens, six adults of both sexes and a half grown young male were taken in western Szechwan, Ramala Pass, Shuowlow, and Nachuka, in August, 1908, at altitudes ranging from 14,000 to 15,500 feet.

The young is very different in color-pattern from the adult, the plumage of both upper and under parts being much marked and variegated with gray and buff on a dark brown ground color, giving the young bird a grouse-like appearance.

Perdix hodgsoniae sifanica Prjevalsky.

Five adults, both sexes, Tachienlu, Ramala Pass, and Lanerhyingpa, western Szechwan, 11,000 to 15,000 feet, midsummer.

This form is certainly only a smaller and otherwise slightly different subspecies of *P. hodgsoniae*. The principal color difference is that *P. h. sifanica*

lacks the black breast patch of true *hodgsoniae*; the other supposed color characters appear to be very variable.

COTURNIX JAPONICA (Temminck & Schlegel).

Twenty specimens, both sexes, Ichang, and Changyanghsien, western Hupeh, autumn, and April.

This series is entirely referable to this very distinct species. Some young males have a little black on the throat, but they show the long lanceolate throat feathers. Some young females show the elongate throat feathers very slightly, but otherwise are exactly like more adult females that show this character very plainly.

BAMBUSICOLA THORACICA (Temminck).

Four adult males, Kiating, Chungking, and Yachow, western Szechwan, November, and December.

ITHAGENES GEOFFROYI Verreaux.

Eight specimens, seven adults of both sexes, and one young male less than half grown were taken at Tachienlu, Tongolow, Shuowlow, Ramala Pass, and Kaoerhshan, western Szechwan, at altitudes ranging from 12,000 to 15,500 feet, in July, and August.

The young male, Tachienlu, 12,000 feet, July 19, 1908, has the head and nape blackish ashy, and the body feathers with conspicuous pale shaft-stripes; the gray tail feathers and pointed red tail-coverts of the adult plumage are just beginning to show.

ITHAGENES WILSONI, sp. nov.

Two adult males, Washan, western Szechwan, 9,000 feet altitude, November 2, 1908.

Type:—No. 52366 M. C. Z. adult ♂. Western Szechwan: Washan Mountain, 9,000 feet, November 2, 1908. W. R. Zappey.

Characters:— Similar in general to *I. geoffroyi* but about *one third smaller*. In color the Washan bird does not differ radically from *I. geoffroyi*, though there are some slight variances; the tail in *I. wilsoni* is rather darker ashy; and the white shaft-lines on the back, scapulars, and upper tail-coverts are wider.

Measurements.

No.	*Sex.*	*Wing.*	*Tail.*	*Tarsus.*	*Culmen.*
52366	♂	169	123.	55.	21.
52367	♂	171	129.	58.	21.

In a series of four adult males of *I. geoffroyi*, the wing averages, 211, the tail 167, the tarsus, 66, and the culmen 24.5.

We have named this little species after Mr. E. H. Wilson to whose energy and executive ability much of the success of the Arboretum Expedition is due.

This species is entirely isolated in the Washan Mountain and apparently is not common there. Mr. Zappey at the time of its capture noticed its small size, and other differences separating it from *I. geoffroyi* which he had taken at Tachienlu.

Tragopan temmincki (J. E. Gray).

Three adults, two males, Fangshen, Hupeh, July, and one female from Washan, western Szechwan, November.

Crossoptilun tibetanum (Hodgson).

Nine specimens, adults of both sexes and one young female about one third grown, Cheto, Tachienlu, Shuowlow, and Tongolow, western Szechwan, 12,000 to 14,000 feet, midsummer.

Phasianus torquatus kiangsuensis Buturlin.

Eight adult specimens, both sexes, Ichanghsien, Hsienshanhsien, Changhsien, Kunganhsien, Hupeh. All were taken in winter except one taken in June.

Phasianus holdereri Schalow.

Thirteen adult specimens both sexes Tawan, Changyanghsien, Hsienshan, Mafuling, Puerhyangtze, and Kwangpow, Hupeh, spring, summer, autumn, and winter. Taken at altitudes ranging from 2,500 feet to 6,000 feet.

There can be no doubt as to the correct identification of these pheasants, which occur so very near each other, in fact in the same general region, though usually at different altitudes; and yet they hold their distinguishing characters so constantly that there is not one in the series in the least degree intermediate.

Mr. Zappey tells us that in Hupeh, the habits of *P. torquatus kiangsuensis*, and *P. holdereri* are quite different. The former being almost wholly restricted,

at all seasons, to the low ground of the river bottoms or as he expressed it being "semiaquatic," not only feeding and living in the wet marshes and rice-fields, but "roosting there at night, sometimes in places where the water is part way up its legs." He, however, took one male and two females in the upland country at Hsienshanhsien.

Phasianus holdereri, which is rather the more abundant, is on the other hand wholly a bird of the rolling upland country at altitudes ranging from 2,000 to 6,000 feet and probably even higher; it was never seen in the lowlands.

While thus apparently specifically distinct from *P. torquatus*, *P. holdereri* is in all probability a subspecies of *P. decolatus*; the descriptions of *P. berezowskyi* Rothschild, suggesting strongly its relationship to *decolatus* on the one side and to *holdereri* on the other.

The two species, with which we here deal, are easily separated in the adult male plumage by the following characters.

P. HOLDERERI.

1. White collar always narrow; commonly very incomplete; usually not, though sometimes very narrowly connecting behind; sometimes altogether wanting.
2. Head, with no distinct paler superciliaries; crown and occup concolor, or very nearly so, with nape.
3. Wing-coverts, olive-gray.
4. Rump greener.
5. Black bands on tail wider.
6. Size a little larger.

P. KIANGSUENSIS.

1. White collar, always wide, always connecting behind.
2. Head with conspicuous whitish superciliaries; crown and occup much duller, more brownish, than nape.
3. Wing-coverts ashy gray.
4. Rump grayer.
5. Black bands on tail narrower.
6. Size a little smaller.

The slight difference in size is the only character for the separation of the females, and this while it gives good average differences in the two series before

us, is within the limit of failure, if one should have a single unusually large specimen of one species, or a single unusually small one of the other.

Scores of pheasants of these two species were shot for food, and Mr. Zappey's notes were based on infinitely more material, than the comparatively small series made into skins. Transportation and space had constantly to be considered where large birds were concerned.

We cannot leave this subject without noticing Buturlin's Distribution of the true pheasants (Ibis, July, 1904, ser. 8, **4**, 377–414). For the systematic part of this very convenient summary we have only praise. This author has turned out a piece of work vastly better than that of any of his predecessors, and has also clearly shown the number of recognizable races and species into which pheasants in a state of undisturbed nature, divide and the very small area usually occupied by each.

. . On points of synonymy however, he is in some cases, entirely in the wrong.

It would be, we admit, an easy way of avoiding difficulties if when with adequate material a wide ranging, variable species is divided into its natural subspecies, the names of early authors could be ignored. This high-handed practice, however, can not be allowed. Buturlin disregards the fact that Gmelin's name *Phasianus torquatus* for the collared pheasant of China was quite adequate to Gmelin's time and must stand. *P. torquatus torquates* must be used for some subspecies. We therefore use it for the one of southeastern China, to which Buturlin gave the name *P. holdereri gmelini*:— first, because this was apparently the last race left without a name; secondly, because Buturlin himself thinks it most probably the one to which Gmelin's name was applied; and thirdly, because it was the form to which David and Oustalet restricted the name.

Equally unpardonable on this author's part is his treatment of *Phasianus torquatus pallasi* Rothschild. Later when ample material shows that an author confused two or more forms under one name it is not customary to discredit the earlier authors' species entirely, but to restrict his name to one of the forms.

Phasianus elegans Elliot.

Eleven specimens, adults of both sexes and two small chicks, Washan, Tachienlu, and Tashanling, western Szechwan, 6,000 to 10,000 feet, summer, and autumn.

A female taken at Kiating in the lowlands of south central Szechwan,

December 14, 1908, Mr. Zappey thinks belongs to another species, possibly *P. decollatus* Swinhoe. Pheasants were very scarce at Kiating and the few seen were very wild. He thought that the one or two males though observed at a distance, were not the same as *P. elegans* which he had taken in the mountains. The only difference we can see in the skin from Kiating is that it is a little larger than females of *P. elegans* and has a slightly larger bill.

Syrmaticus reevesi (J. E. Gray).

Thirteen adults, both sexes, Kwangpow, Changyanghsien, Putze, and Tawan, Hupeh, spring, autumn, and winter.

This magnificent game bird inhabits principally the oak belt on the mountains at from 2,000 to 5,000 feet where it feeds upon acorns.

Some of the specimens taken are superb with absolutely perfect tails, one measuring when stretched to its full length no less than six feet, nine and three fourths inches.

Chrysolophus pictus (Linné).

Seven specimens, adults of both sexes and one young male. Tawan, Ichanghsien, Changyanghsien, and Kweichowhsien, Hupeh, winter, spring, and autumn.

The Golden pheasant, though very common in these regions, is extremely hard to shoot, as it keeps to the dense bamboo thickets, and refuses to take wing even when hunted with a dog.

Chrysolophus amherstiae Leadbeater.

Three adult males, Washan, and Wuyaling, western Szechwan at 8,000 feet, May, and October.

TURNICIDAE.

Turnix blanfordi Blyth.

Seven specimens, both sexes, Ichang, Hupeh, September, and October.

COLUMBIDAE.

Columba leuconota Vigors.

Four specimens adults of both sexes, Tachienlu, Mohsimien, western Szechwan, July, 1908. The Snow pigeon was constantly seen at altitudes

ranging from 7,500 to 12,500 feet and even higher, but on account of the nature of the country it inhabits only four specimens were secured.

Columba rupestris rupestris Bonaparte.

Seven specimens, adults of both sexes, Washan, Tongolow, Waszekow, Nachuka, western Szechwan, at altitudes ranging from 5,000 to 12,500 feet, July, and August.

PERISTERIDAE.

Turtur orientalis (Latham).

Sixteen specimens, both sexes, Ichang, Ichanghsien, Yangchaho, Changyanghsien, Ituhsien, Hsienshan, Hsienshanhsein, Mafuling, Shihtowya, and Fangshen, Hupeh; Nachuka, Tachienlu, and Luitingchiao, Szechwan; all seasons and altitudes up to 12,000 feet.

Streptopelia decaocta (Frivaldszky).

Two adult males, Ichanghsien, Hupeh, February.

Onopopelia humilis (Temminck).

Twenty specimens, young and adult, both sexes, Ichang, Hupeh, and Tachienlu, western Szechwan, spring, summer, and autumn.

Spilopelia chinensis (Scopoli).

Twelve specimens, young and adult, both sexes, Ichang, and Kunganhsien, Hupeh; Kiating, and Omeihsien Szechwan; spring, summer, and autumn.

RALLIDAE.

Rallus aquaticus korejewi Saruduy.

Plate 3, fig. 1.

One adult male, in full spring plumage, Ichanghsien, Hupeh, March 8, 1908.

Our skin agrees exactly in every detail, with the description of this strongly marked subspecies; the record, however, greatly extends its range.

Rallus indicus Blyth.

One immature female Ichang, Hupeh, September 16, 1907.

Hypotaenidia striata (Linné).

One youngish female, Ichang, Hupeh, September 18, 1907.

Porzana auricularis Reichenow.

Three males, none in fully adult plumage, Ichang, Hupeh, September and October.

Porzana bicolor Walden.

Two adult males, Washan, western Szechwan, May 29, and June 7, 1908, 6,000 feet.

This rail was not uncommon on the Washan Mountains where it was breeding; it proved very hard to shoot, and although two nests were found, one with six the other with five eggs, the parent birds were not secured. A bird was seen, as it left its nest and five eggs, and positively identified as belonging to this species. Both nests, one taken May 30, the other June 5 were found in small reedy islands in mountain streams.

Ortygops exquisita (Swinhoe).

One adult female, Luchow, central Szechwan, April 26, 1908.

Limnobaenus fuscus (Linné).

One adult male, Ichang, Hupeh, July 8, 1907.

Amaurornis phoenicura (Forster).

Twenty-one specimens, adults of both sexes, and six little wholly black chicks July 21, Ichang, Hupeh, spring, summer, and autumn.

Gallinula chloropus orientalis Horsfield.

One adult male, Ichang, Hupeh, June 17, 1907.

Gallicrex cinerea (Gmelin).

Three specimens, an adult male, a young male, and a young female the young in the brown plumage, Ichang, Hupeh, July, September, and October.

COLYMBIDAE.

Colymbus cristatus Linné.

One male, in winter plumage, Chachianghsien, western Szechwan, December 7, 1908.

Tachybaptus ruficollis poggei (Reichenow).

Two adult females, Ichang, Hupeh, September, and October.

The collection of the Museum of Comparative Zoölogy contains also two fine adults, ♂ and ♀, from Pekin. These specimens indicate that the slight characters that distinguish the Chinese form from true *T. ruficollis* (Pallas) and *T. r. philippensis* (Bonnaterre) are not wholly constant, and the subspecies is certainly not a strongly marked one.

LARIDAE.

Sterna sinensis Gmelin.

Seven specimens, adults of both sexes, Luchow, and Kiating, Szechwan, April, and May.

Larus ridibundus Linné.

Four specimens, three adults of both sexes in winter plumage and one immature female, Ichang, and Changhsien, Hupeh, February, and March.

Larus affinis Reinhardt.

One female, immature, in probably its second year, Chachianghsien, western Szechwan, December 7, 1908.

Larus canus Linné.

One immature female, Yachow, western Szechwan, December 5, 1908.

CHARADRIIDAE.

Microsarcops cinereus (Blyth).

Three specimens, two adult females and a youngish male, Ichang, Hupeh, March, and October.

Vanellus vanellus (Linné).

Five specimens, both sexes, Ichang, Hupeh and Chiachianghsien, Kiating, Kungyahsien, and Omeihsien, Szechwan, autumn, and winter.

CHARADRIUS DOMINICUS FULVUS (Gmelin).

Two females, Ichang, Hupeh, October.

OCHTHODROMUS VEREDUS (Gould).

One female, Lochichen, eastern Szechwan, April 10, 1908.

AEGIALITIS PLACIDA (Gray).

Twenty-six specimens, both sexes, Ichang, and Lanjung, Hupeh, and Nanchihsien, Suifu, Kiating, Changshowhsien, Hochianghsien, and Chiachianghsien, Szechwan, autumn, and spring, some as late as May 5.

AEGIALITIS DUBIA (Scopoli).

Nine specimens, both sexes, Ichang, Hupeh, and Hochianghsien, Chiangchinghsien, Chungking, and Luchow, Szechwan, March, April, and October.

AEGIALITIS ALEXANDRINA (Linné).

One female, in winter plumage, Ichang, Hupeh, October 10, 1907.

This is, of course, *Ae. alexandrina dealbata* (Swinhoe) if that race is recognizable, which does not seem to be the case.

IBIDORHYNCHUS STRUTHERSI Vigors.

Five specimens, adults of both sexes, Yachow, Chiachianghsien, and Shuowlow, western Szechwan, summer, and autumn.

TOTANUS ERYTHROPUS (Pallas).

Four females, Ichang, Changkow, Hupeh, October, and February.

HELODROMAS OCHROPUS (Linné).

Twenty-four specimens, both sexes, Ichang, Ichanghsien, and Changhsien, Hupeh, and Luchow, Washan, Dar-chi-kwan, Omeihsien, and Kiating, Szechwan, all seasons. May 5 is the latest date in spring on which a Green sandpiper was taken and July 8 is the earliest summer date.

ACTITIS HYPOLEUCUS (Linné).

Seven specimens, both sexes, Ichang, Hupeh, and Omeihsien, Chiachianghsien, and Shuowlow, Szechwan, autumn, and spring.

Glottis nebularius (Gunnerus).

Seven specimens, both sexes, Ichang, and Changkow, Hupeh, and Kiating, and Chiachianghsien, Szechwan, autumn, and winter.

Rhyacophilus glareola (Gmelin).

One adult female, Yachiakun, western Szechwan, 13,000 feet, July 14, 1908.

Pisobia damacensis (Horsfield).

One male, Ichang, Hupeh, October 22, 1907.

Pisobia temmincki (Leisler).

Three females, Ichang, Hupeh, and Luchow, central Szechwan, April.

Pelidna alpina sakhalina (Vieillot).

Two females, Ichang, Hupeh, October.

Gallinago stenura (Ruhl).

Twelve specimens, both sexes, Ichang, Hupeh, August, September, and April.

Gallinago megala Swinhoe.

Ten specimens, both sexes, Ichang, Hupeh, August, and April.

Gallinago gallinago (Linné).

Eleven specimens, Ichang, Hupeh, September, November, March, and April.

Scolopax rusticula Linné.

Fourteen specimens both sexes Ichang, Ituhsien, Nochaping, and Kwangpow, Hupeh, and Kiatung, and Chichiang, Szechwan, autumn, winter, and spring.

Rostratula capensis (Linné).

Nine specimens, both sexes, Ichang, Hupeh, September, and October.

CURSORIIDAE.

Glareola maldivarum (Forster).

Twenty-six specimens, both sexes, Kiating, Nichichang, Suifu, and Kungyahsien, Szechwan. All taken early in May, except one pair shot at Kungyahsien, June 21, 1908. The lateness of this date indicates that the bird breeds in this region.

ARDEIDAE.

Ardea cinerea jouyi Clark.

Twenty-one specimens, young and adult of both sexes, Ichang, Hupeh, and Tachienlu, Chiachianghsien, and Chungchowhsien, Szechwan, all seasons. From a large colony that was nesting in a grove surrounding a temple at Chungchowhsien Mr. Zappey secured on April 5, 1908, a fine series of birds in full nuptial plumage.

On comparing this large series with a number of skins from Europe, the pale colors of the eastern bird stand out in marked contrast and the race is easily recognizable.

Mesophoyx intermedia (Wagler).

One male, in winter plumage without plumes and with a black tip to the bill, Ichang, Hupeh, October 9, 1907.

Herodias alba (Linné).

One adult male, M. C. Z. No. 52976, with the dorsal plumes fully developed, but with a yellow bill, Ichang, Hupeh, February 24, 1909.

From the large size of this specimen (surpassing most European skins) it seems impossible to refer it to *N. timoriensis* (Lesson), although it has light colored tibiae and a yellow bill at a time when the dorsal plumes are developed. It is of course possible that the dorsal plumes were carried over from the last breeding season, and that the bill would change to black.

The measurements are: — wing, 448.; tail 175; tarsus, 198.; culmen, 138.

Garzetta garzetta (Linné).

Nine specimens, adults of both sexes, Chichiang, Minchihsien, Yachow, and Kungyahsien, Szechwan, June, October, November, and December.

Nycticorax nycticorax nycticorax (Linné).

Nine specimens, young and adults, both sexes, Hupeh and Changshowhsien, eastern Szechwan, spring, and summer.

Butorides javanica javanica (Horsfield).

Three specimens, adults of both sexes, Ichang, Hochiaping, and Yangchiatamiao, Hupeh, spring, and summer.

Ordeola bacchus (Bonaparte).

Seventeen specimens, young and adults of both sexes, Ichang, and Hungtzekow, Hupeh, and Omeihsien, and Chiachianghsien, western Szechwan, spring, summer, and autumn.

Bubulcus coromandus (Boddaert).

Eleven specimens, young and adults of both sexes, Hungyahsien, and Omeihsien, western Szechwan, summer, and autumn.

Ixobrychus sinensis (Gmelin).

Two males, Ichang, Hupeh, September, and October.

Nannocnus eurythmus (Swinhoe).

Eighteen specimens, young and adults of both sexes, Ichang, Hupeh, and Washan, and Omeihsien, western Szechwan, summer, and autumn.

Dupetor flavicollis (Latham).

One young female Ichang, Hupeh, October 3, 1907.

Botaurus stellaris (Linné).

Seven specimens, both sexes, Ichang, Kunganhsien, Hupeh, and Changshowhsien, Szechwan, autumn, and winter.

These specimens show as is usually the case in a series of skins of the bittern, that there is considerable variation in size and that while the females are smaller than the males, individual variation is still very great.

ANATIDAE.

Melanonyx segetum serrirostris (Swinhoe).

Three specimens, all youngish, one male and two females, Shasi, Hupeh, and Changshowhsien, Szechwan, February.

Immense numbers of geese were seen in the low country but they were extremely wary, and a rifle could not be used on account of the dense population. Other species, as well as swans, were seen.

Anas platyrhynchos Linné.

Sixteen specimens, both sexes, Ichang, Kunganhsien, Hsienshanhsien, Hupeh, and Kiating, Washan, Kungyahsien, Chiachianghsien, and Yachow, Szechwan, taken throughout the winter, November to March.

Polionetta zonorhyncha (Swinhoe).

Eleven specimens, both sexes Kiating, Kungyahsien, Chiachiang, and Yachow, western Szechwan, all taken in December.

Marcea penelope (Linné).

Two males, one in immature the other in full adult plumage, Kiating, and Washan, western Szechwan, October, and December.

Nettion formosum (Georgi).

One adult female, Ichang, Hupeh, November 26, 1907.

Nettion crecca (Linné).

Twenty-one specimens, both sexes, Ichang, Changyanghsien, Shasi, and Yangtze near Shasi, Hupeh, and Yachow, Kiating, Kungyahsien, and Washan, Szechwan, taken throughout the winter from October to March.

Dafila acuta (Linné).

One female, Washan, western Szechwan, 6,000 feet, October 25, 1908.

Querquedula querquedula (Linné).

Five specimens, both sexes, Ichang, Hupeh, and Washan, western Szechwan, October.

Many of the Anatidae taken by Mr. Zappey are more or less colored a rusty red on the underparts; this is due to some extraneous stain obtained from the water and while all the specimens taken near Ichang are comparatively free from discoloration all those taken in small streams and ponds at higher altitudes are similarly discolored.

NETTA RUFINA (Pallas).

One very fine adult male in full plumage, Kiating, western Szechwan, November 22, 1908.

MARILA FERINA (Linné).

One adult male, Kiating, western Szechwan, November 22, 1908.

MARILA FULIGULA (Linné).

Four males, none in full adult plumage, Ichang, Hupeh, and Kiating, western Szechwan, November.

CLANGULA CLANGULA CLANGULA (Linné).

One adult male, Yachow, western Szechwan, December 5, 1908.

MERGELLUS ALBELLUS (Linné).

Two specimens, male and female, the male in eclipse plumage similar to that of the female, Ichang, Hupeh, November, and December.

MERGUS MERGANSER MERGANSER Linné.

Four specimens, adults of both sexes, Ichang, Hupeh, and Kiating, Szechwan, December, and January.

It is of course problematical where these birds were bred and they perhaps should all be referred to *M. m. comatus*, rather than to *M. m. merganser*, all being smaller than European specimens. In the slight color differences, and the character of the crest of the male, they are more or less intermediate though on the whole nearer to true *M. m. merganser*.

MERGUS MERGANSER COMATUS (Salvadori).

Two specimens, male and female adult, Kungyahsien, western Szechwan, December 6, 1908.

These skins are certainly referable to this subspecies; both are small and show all the characters of the Himalayan goosander.

They afford the following measurements:—

No. 52943, adult ♂, wing, 269; culmen, 54; tarsus, 45.

No. 52944, adult ♀, wing, 253; culmen, 46; tarsus, 41.

Mergus squamatus Gould.

Six specimens, two adult males, three adult females and one young male. Ichang, Hupeh, and Yachow, Kiating, and Kungyahsien, Szechwan, November and December. The young male has the sides, lower back, and rump as in the adult, except that the squamatulations are not so black or so pronounced; the upper back is gray and the head is rusty, like that of the female, but paler and with no white on the throat; the crest, however, is nearly as long as in the adult.

This Merganser has been a very rare bird in collections; and for a long time was known only from the type, an immature male. Ogilvie-Grant, recently described, and figured for the first time, the adult male and female (Ibis, 1900, ser. 7, 6, p. 602, pl. 12).

PHALACROCORACIDAE.

Phalacrocorax carbo (Linné).

Five specimens, adults in non-breeding plumage and one young female, Kiating, and Yachow, western Szechwan, December.

These skins belong to the smaller, small-billed oriental race, which if recognized would probably bear the name, *Phalacrocorax carbo sinensis* Shaw and Nodd; the series of skins we have examined is not sufficient in numbers or in the range of the species to enable us to decide; Indian and Chinese birds are however noticeably small.

FALCONIDAE.

Circus cyaneus (Linné).

Four specimens, two adult males, one female and one young male, Ichang, Ichanghsien, Changkowhsien, and Ituhsien, Hupeh, winter (November 20 to February 18).

Circus spilonotus Kaup.

One male, not fully adult, Shihtowya, Hupeh, April 18, 1907.

Astur palumbarius khamensis Bianchi.

Two specimens, male and female both in immature plumage, Ichang, Hupeh, November 20, 1907, and Ramala Pass, western Szechwan, 13,500 feet, August 11, 1908.

We are not positive that birds in immature plumage can be distinguished from the young of true *A. palumbarius*; our skin from the Ramala Pass is, on geographical grounds, *khamensis*, and the female in similar plumage, from Ichang, agrees exactly with it, so that we refer both to the same form. An additional reason for doing so is that the sparrow hawk of our region (also originally described by Bianchi from eastern Tibet) ranges east to Ichang.

Astur soloensis (Latham).

Two males, one adult, one immature, Ichang, and Ichanghsien, Hupeh, June 10, and August 26, 1907.

If *A. soloensis* and *A. cuculoides* (Temminck) are distinct and not individual extremes of coloration of one species then the adult male before us is an intermediate, about as well referred to one as to the other.

Accipiter nisus lodygini Bianchi.

Eighteen specimens, young and adults of both sexes, Ichang, and Changyanghsien, Hupeh, and Washan, Kiating, Nichichang, Kungyahsien, and Darchi-kwan, western Szechwan, all seasons.

While our skins agree exactly with Bianchi's description, we have not been able to examine a specimen of *A. melanoschistus* Hume, and Bianchi makes no mention of that form, which by description would seem to be very similar to the Tibetan-central China sparrow hawk.

It is not easy to separate young birds of this subspecies from true *A. nisus* in corresponding stages of plumage, but there is no difficulty whatever in distinguishing adult males; the dark slaty black back and preponderance of rufous on the underparts is very different from the gray back and pale underparts of *A. nisus nisus*.

Birds killed in the neighborhood of Ichang are quite as extreme as those from western Szechwan which is in the same general faunal region as Kham, Tibet, the type locality; the subspecies thus has a wide range. Specimens from near Pekin are very pale and quite different from the bird of our region.

As illustrative of the fierceness of this little hawk, Mr. Zappey states that

on February 3, 1909 at Changyanghsien, he wounded a Golden pheasant, when immediately an adult male sparrow hawk dashed upon it, killed, and began devouring it.

ACCIPITER GULARIS (Temminck & Schlegel).

One immature female, Ichang, Hupeh, September 15, 1907.

BUTEO BUTEO PLUMIPES (Hodgson).

Five specimens both sexes, only one male in uniform chocolate-brown plumage (the fully adult dress?). Ichang, and Changkowhsien, Hupeh, and Washan, Szechwan, winter, and spring.

GYPAËTUS BARBATUS (Linné).

One male, Ichang, November 20, 1907. The Lammergeier was not uncommon, but it was almost impossible to kill one with a charge of shot, and to use a rifle was generally out of the question.

MILVUS MELANOTIS Temminck & Schlegel.

Seven specimens, young and adults, both sexes, Ichang, and Changyanghsien, Hupeh, and Minchihsien, Washan, and Kiating, Szechwan, autumn, and winter.

FALCO PEREGRINUS ATRICEPS Hume.

Two specimens, an adult female, Wushanhsien, eastern Szechwan, March 26, and an immature male Ichang, Hupeh, June 28.

FALCO AESALON Turnstall.

One immature male, Ichanghsien, Hupeh, February 10, 1909.

CERCHNEIS SATURATA (Blyth).

Six specimens, adults of both sexes and immature males, Ichang, Hupeh, and Wushanhsien, and Washan, Szechwan, autumn, and spring.

STRIGIDAE.

ASIO OTUS (Linné).

Two specimens, both males, Ichanghsien, and Changyanghsien, Hupeh, November 16, 1907, and March 14, 1908.

Asio flammeus (Pontoppidan).

Three specimens, both sexes, Ichang, and Shasi, Hupeh, February 5, and May 1.

Bubo bubo setschuanus Reichenow.

One female, Ichang, Hupeh, October 23, 1907.

Otus semitorques plumipes (Hume).

Two adults, male and female, Hsienshan, and Changyanghsien, Hupeh, June 4, 1907, and January 29, 1909.

These specimens have feathered toes, and seem to agree in every way with the descriptions of the Himalayan form of the Japanese *Otus semitorques*. However we have seen no Himalayan specimens.

Our ♂, No. 53060, M. C. Z. has the wing, 163. mm. long, and the ♀, No. 53061, M. C. Z. has the wing, 177. mm. long.

Strix nivicola (Hodgson).

One adult male, Washan, western Szechwan, 8,000 feet, November 1, 1908.

Strix davidi (Sharpe).

One adult ♀, Shuowlow, western Szechwan, 14,000 feet, August 19, 1908.

Glaucidium whitelyi (Swinhoe).

Twenty-one specimens, both sexes, Ichang, Kwatzeling, Changyanghsien, and Ituhsien, Hupeh, and Chiachianghsien, Omeihsien, Kiating, Luchow, Kungyahsien, and Yachow, Szechwan, all seasons.

PSITTACIDAE.

Palaeornis derbyana salvadorii Oustalet.

Seven specimens, two adult males, two adult females, and three young males, Nachuka, western Szechwan, 10,000 to 12,000 feet, August, 1908.

This parrot is apparently rare and local. Mr. Zappey found it, in small numbers, only, at one or two places, where he was so unfortunate as to lose several fine adults, that when shot fell over cliffs into inaccessible ravines.

The differences in color that were at one time (see Ogilvie-Grant, Ibis, 1900, ser. 7, 6, p. 600) thought to distinguish *P. derbyana* Fraser from *P. salvadorii* Oustalet are sexual, males have bright red upper mandibles, no brownish mark across the neck, and lavender-blue underparts; females have black upper mandibles, a brownish purple marking crossing the side of the neck, and lavender-lilac underparts.

Young males have red bills, the inner edges of their primaries are yellowish green, their tails are short and their underparts, crowns, and under wing-coverts are mostly green.

Rothschild (Bull. B. O. C., 1899, 8, p. lvi) considers it best until the original locality of *P. derbyana* is known to recognize *P. salvadorii* as a subspecies on account of its apparently smaller size. Our two adult males have the wing 216 and 218 mm. and the two adult females, 210 and 213 mm.

CORACIIDAE.

Eurystomus calonyx Sharpe.

Five adults, both sexes, Fangshen, and Shuiyuehtze, Hupeh, May.

ALCEDINIDAE.

Ceryle lugubris guttulata Stejneger.

Nine specimens, adults of both sexes, Ichang, Changyanghsien, and Hsienshanhsien, Hupeh, and Hungyahsien, Szechwan, autumn, and winter.

Alcedo ispida bengalensis (Gmelin).

Twenty-three specimens, both sexes, Ichang, Hupeh, and Kiating, and Luchow, Szechwan, all seasons.

Halcyon pileatus (Boddaert).

Five adults, both sexes, Ichang, Ichanghsien, Yangchiatamiao, and Hsienshanshan, Hupeh, May, June, September, and October.

UPUPIDAE.

Upupa epops saturatus Lönnberg.

Twelve specimens, both sexes, Ichang, Hupeh, and Shuowlow, Foochow, Nachuka, and Tongolow, Szechwan. Taken in January, February, March,

April, and August. It is thus not certain that any of these were birds that would breed in the region. All are referable to this lately described form, the best character of which, as compared with European skins is the conspicuously darker interscapular region.

CAPRIMULGIDÆ.

Caprimulgus indicus jotaka Temminck & Schlegel.

One young male (in plumage not unlike that of the adult female), Ichang, Hupeh, September 13, 1907.

MICROPODIDAE.

Collocalia inopina inopina Thayer & Bangs.

The type from Mafuling, Hupeh, taken June 1, 1907, was the only example of this form secured; others, however, were seen in the same general region.

Collocalia inopina pellos, sub. sp. nov.

Type:— No. 52131 M. C. Z. adult ♂, Western Szechwan: Washan, 6,000 feet, May 31, 1908. W. R. Zappey.

Characters:— Similar to true *C. inapina* from Hupeh, and of the same size, but upper surface darker, more sooty, less brownish, and more uniform,— the rump scarcely paler than the back.

Measurements:— Type, adult male, wing, 135; tail, 59; tarsus, 11.5; culmen, 5. Topotype, adult ♀, No. 52125, wing, 134; tail, 60; tarsus, 12; culmen, 5.

Remarks:— Thirteen specimens of this form were secured at Chungchowhsien, and Washan, Szechwan, where it was fairly common, in April and May. It appears to be easily distinguished from its more eastern representative, true *C. inopina*, by its much darker, more sooty, and uniformly colored back, without paler rump.

Collocalia fuciphaga capnitis Thayer & Bangs.

Bull. M. C. Z., May, 1909, **52**, p. 139.

One adult male, the type, Wantaoshan, Hupeh, June 5, 1907. But one specimen of this much smaller bird (the wing 10 mm. shorter than in *C. inopina*) was taken.

Chaetura caudacuta (Latham).

One male, Ichang, Hupeh, October 19, 1907.

Chaetura nudipes Hodgson.

Two adult males in full spring plumage, Hokow, western Szechwan, May 4, 1908.

Apus pacificus (Latham).

Thirteen specimens, adults of both sexes, Waszekow, Wuyaling, and Tachienlu, western Szechwan, summer, and autumn.

CUCULIDAE.

Hierococcyx sparveroides (Vigors).

Two adult males, Luchow, and Hochinghsien, Szechwan, April, 1908.

Cuculus micropterus micropterus Gould.

One male, not quite adult, Ichang, Hupeh, July 19, 1907.

Cuculus canorus telephonus Heine.

Ten specimens, young and adults of both sexes, Ichang, Fanghsien, and Hsientientze, Hupeh, and Washan, Szechwan, spring, summer, and autumn.

Cuculus optatus Gould.

Three specimens, females — two adults and one young. Tachienlu, western Szechwan, July, and August, 1908.

Cuculus intermedius intermedius Vahl.

Four adults, both sexes, Washan, and Tachienlu, western Szechwan, May, June, and July.

Chalcococcyx maculatus (Gmelin).

Three adult males, Hsienshanhsien, and Hsientientze, Hupeh, May, and June.

Eudynamis honorata (Linné).

Four adults, both sexes, Ichanghsien, Hsienshanshan, and Hsienshan, Hupeh, and Chiachianghsien, western Szechwan, May, and June.

PICIDAE.

Picus canus guerini (Malherbe).

Thirty-six specimens, both sexes, Ichang, Ichanghsien, Changyanghsien, Hochaping, Yangtze near Shasi, Kunganhsien, Ituhsien, Putze, Hsienshan, Omeihsien, Shaiyüehtze, and Hsienshanhsien, Hupeh, and Cheto, western Szechwan, all seasons.

Not one of these numerous skins, can be referred to *Picus occipitalis* (Vigors) though many approach it. Two skins from Cheto, for instance that on geographic grounds might be expected to be *occipitalis* have the completely barred tail of *guerini*, but they also have almost wholly black bills, the yellowish green of the lower mandible, so conspicuous in *P. guerini*, being restricted to a small spot near the base. Other specimens from Hupeh, occasionally show almost wholly black tails, but invariably have the yellowish lower mandible; and there is not one in the series that combines the black unbarred tail with the black bill.

Hypopicus hyperythrus subrufinus (Cabanis & Heine).

Two adults, male and female, Tachienlu, July 7, 1908, and Nochianghsien, Szechwan, April 23, 1908.

This species is very rare in the region under consideration; one other individual was shot but not secured.

Dryobates cabanisi cabanisi (Malherbe).

Thirty-six specimens, young and adults of both sexes, Ichang, Hsienshanhsien, Chiliping, Shihtowya, Changkowhsien, Ituhsien, Changyanghsien, and Ichanghsien, Hupeh, and Wulungshih, Shuowlow, and the Ramala Pass, Szechwan, all seasons. No variation in any way correlated to altitude or locality in this large series can be traced; skins from Ichang being, on the whole, similar to those from western Szechwan at 15,000 feet. Individual variation in the color of the under parts, the color and width of the frontal band, the intensity of the red of the belly and under tail-coverts, and other minor points, is very great. The white marking, on the inner secondaries also varies somewhat.

Dryobates pernyi pernyi (Verreaux).

Two adults, a male taken at Changyanghsien, Hupeh, January 24, 1909, and a female shot at Wantaoshan, Hupeh, June 5, 1907.

Styan (Ibis), has already commented on the great rarity of this species, to which we can only add Mr. Zappey's experience, who in two years of active field work saw but these two individuals.

Picoides funebris Verreaux.

One male, Shuowlow, western Szechwan, 14,500 feet, August 23, 1908. This bird, a young male of the year, was moulting from the nestling plumage, to that of the adult.

During his whole stay in western Szechwan Mr. Zappey had hunted the high coniferous forest for this species, but until the above mentioned date his efforts were fruitless. On August 23, however, the pounding of a woodpecker in the dense firs attracted his attention and later he discovered two three-toed woodpeckers. Although Mr. Zappey waited a long time that both might be secured at one shot he was obliged to select one; thorough search failed to rediscover the second.

Yungipicus scintilliceps scintilliceps (Swinhoe).

Twenty-nine specimens, both sexes, Ichang, Hsientientze, Hsienshanhsien, Kwatzeling, Shihtowya, and Changyanghsien, Hupeh, all seasons.

Picumnus innominatus chinensis (Hargitt).

One adult female, Changyanghsien, Hupeh, November 13, 1907.

HIRUNDINIDAE.

Hirundo urbica cashmeriensis (Gould).

Twenty-one specimens, adults of both sexes, Washan, and Tsaikow, western Szechwan, summer.

Riparia riparia (Linné).

Two specimens, a male taken at Juchi, Szechwan, April 20, 1908, and a female from Washan, Szechwan May 30, 1908. Probably both these birds were migrants, the one killed May 30, being in company with a number of migrating *Chelidon tytleri*.

Riparia folkienensis LaTouche.

Thirteen specimens, young and adults of both sexes Ichang, Hupeh, and Changshowhsien, Wanhsien, Luchow, and Foochow, eastern Szechwan, spring,

summer, and autumn. This very distinct species, easily separated from *R. riparia* by its small size, pale coloring, and short tail, seems to be the breeding form of Hupeh and eastern Szechwan. The eggs must occasionally be laid very early in the season, as Mr. Zappey took one nearly full grown young bird on the wing at Wanhsien April 2. Others of about the same size and in similar plumage were secured at Ichang on June 18.

Riparia rupestris (Scopoli).

Three adult males, Waliangping, and Waszekow, western Szechwan, October.

Chelidon rustica gutturalis (Scopoli).

Twenty-one specimens young and adult of both sexes Ichang, Hupeh, and Foochow, Luchow, Changyanghsien, Juchi, Chiangchinghsien, and Hochianghsien, Szechwan, spring, and summer.

Chelidon tytleri (Jerdon).

Five adults, both sexes, Washan, Szechwan, May 30, 1908. This species was seen on this one occasion only. They were part of a migrating flock and were feeding throughout a valley (6,000 feet); they had disappeared the following day.

Chelidon daurica nipalensis (Hodgson).

Twenty-three specimens, young and adult, both sexes, Ichang, Hupeh, and Luchow, Chinchihsien, and Lochichen, Szechwan, spring, summer, and autumn.

MUSCICAPIDAE.

Hemichelidon sibirica Gmelin.

One adult male, Ichang, October 10, 1907.

Hemichelidon fuliginosa Hodgson.

Five specimens, adult male and female, and three young in nestling plumage, western Szechwan, August 10–18, 1908: Nachuka, 11,000 feet, Shuowlow, 12,500 feet, and Ramala Pass, 12,000 feet.

Arizelomyia latiros tris (Raffles).

One adult male, Pootung, Hupeh, May 20, 1907.

Siphia albicilla (Pallas).

Five specimens, both sexes, Ichang, and Mafuling, Hupeh, and Omeihsien, Szechwan, May, and October.

Siphia strophiata Hodgson.

Two males, Lianghokow, western Szechwan, 12,000 feet, September. In one of these, in fully adult plumage, the usual crescent of rufous on the chest is replaced with feathers with white bases. This specimen is probably abnormal.

Cyornis tickelliae glaucicomans Thayer & Bangs.

Bull. M. C. Z., May, 1909, **52**, p. 141.

Two adult males, one, the type, from Tanshuiya, Hupeh, May 7, 1907, the other from Hsienshan, Hupeh, June 4, 1907.

Digenea leucomelanura cerviniventris Sharpe.

One male, Washan, June 3, 1908. This was one of a pair that was evidently nesting among the moss-covered rocks of the mountain side; Mr. Zappey was unable to find the nest.

Niltava lychnis Thayer & Bangs.

Bull. M. C. Z., May, 1909, **52**, p. 141.

Plate 3, fig. 2.

The type, an adult male taken at Patung, Hupeh, May 19, 1907, was the only example seen during the trip.

Paliomyias hodgsoni (Verreaux).

Three adult males, Nachuka, Wulungshih, and Ramala Pass, western Szechwan, 12,000 to 15,000 feet, August.

Xanthopygia xanthopygia (A. Hay).

Four specimens, two adult males, an adult female and one male in the spotted nestling plumage, Ichang, Hupeh, and Kungyahsien, Szechwan, June, and July.

Cyanoptila cumatilis Thayer & Bangs.

Bull. M. C. Z., May, 1909, **52**, p. 141.

Eight specimens, adults of both sexes, Mafuling, Hsientientze, and Fangshen, Hupeh, May, and June.

This very distinct species, is quite different from *C. bella* (A. Hay) of Japan and Corea; where found it was not an uncommon breeding bird, though probably very local in its distribution.

Tarsiger chrysaeus Hodgson.

Five specimens, adults of both sexes and young, Washan, Yachiakun, Tachiao, and Lianghokow, western Szechwan at altitudes, ranging from 10,000 to 12,000 feet, June, July, and September.

Tchitrea incei (Gould).

Twenty-two specimens, adults and young of both sexes, Ichang, Ichanghsien, Hsienshan, and Suichanping, Hupeh, and Omeihsien, Szechwan, May to October.

Of the old males with very long tails two are pied, maroon and white; the plumage of about half of the others is in the white phase, the remainder in the maroon phase.

Culicicapa ceylonensis (Swainson).

Five specimens, four adults of both sexes and one nestling, Tanshuiya, Hupeh, and Chungchowhsien, Luluping, and Minchihsien, Szechwan, April, May, and June.

Cryptalopha burkii valentini Hartert.

Eight specimens, adults of both sexes, Hsientientze, Mafuling, Chetzekow, Hsienshan, and Hsienyuehtze, Hupeh, May, and June.

The color characters attributed this form by its describer do not hold in our series — some breeding males having the head-stripes pure gray, while with others there is considerable olive-green mixed with the gray. The wing, however, is much shorter than in *C. burkii tephrocephala* of the west — in six adult males varying from 55 to 57 mm. in length.

Cryptolopha burkii tephrocephala (Anderson).

One adult male, Ramala Pass, western Szechwan, 12,000 feet, August 26. This specimen has the wing 62 mm. in length.

Cryptolopha sinensis Rickett.

One adult male, Hsientientze, Hupeh, June 3, 1907.

Abrornis fulvifacies Swinhoe.

Nine adults, both sexes, Kiating, Nanchihsien, and Chiangchinghsien, Szechwan, April, November, and December.

Eumyias melanops (Vigors).

Five adults, both sexes, Mafuling, and Hsientientze, Hupeh, and Chinshihsien, Szechwan, May, and June.

CAMPEPHAGIDAE.

Volvocivora melanoptera (Rüppell).

Thirteen specimens, adults of both sexes, and one young female in spotted plumage, Ichang, Mafuling, Peiyangsze, Hsienshan, and Shinshenshan, Hupeh, May, June, and July.

Pericrocotus brevirostris (Vigors).

Seven specimens, adults of both sexes, Hsienshan, Chetzekow, Wansonshan, and Showlungtu, Hupeh, and Wulungshih, western Szechwan, spring, and summer.

Pericrocotus cantonensis (Swinhoe).

Eight adults, both sexes, Mafuling, Hupeh, and Luchow, Suifu, and Hochinghsien, Szechwan, spring, and summer.

PYCNONOTIDAE.

Microscelis[1] leucocephalus (Gmelin).

Eight males, Hsienshan, Pootung, Hsienhsienshan, Mafuling, Peiyangsze, Hupeh, and Omeihsien, Szechwan, spring, and summer.

Pycnonotus xanthorrhous J. Anderson.

Twenty-four specimens, young and adult both sexes, Ichang, Yangchiatamiao, and Hsienshanhsien, Hupeh, and Wushanhsien, Kiating, and Chinchihsien, Szechwan, all seasons.

[1] As Hypsipetes, the current name of this genus is preoccupied, we take Microscelis, apparently the first available name.

Pycnonotus sinensis (Gmelin).

Thirty-three specimens, young and adults, both sexes, Ichang, and Kwatze, Hupeh, and Hochianghsien, Wanhsien, and Nanchihsien, Szechwan, and Shanghai, Kiangsu, all seasons.

Spizixus semitorques Swinhoe.

Twenty specimens, both sexes, Ichang, Changyanghsien, Tawan, Kwatzeling, Hsienshanhsien, Shihtowya, and Hsienshan, Hupeh, and Kiating, and Changshowhsien, Szechwan, all seasons.

TIMELIIDAE.

Babax lanceolatus lanceolatus (Verreaux).

Seven adults, both sexes, from Hsientientze, Hsienshanhsien, Changyanghsien, Hochaping, and Kwangpow, Hupeh, taken at all seasons of the year.

Babax lanceolatus bonvaloti Oustalet.

Six specimens, young and adult, both sexes, Ramala Pass, Tachienlu, and Cheto, western Szechwan, midsummer.

The one adult ♂, with a wholly striped belly, from the Ramala Pass, 14,000 feet, is apparently an extreme example of this large, dark western subspecies. As Oustalet has already mentioned Tachienlu specimens are somewhat intermediate, but they are so very much nearer the Tibetan subspecies than to true *lanceolatus*, that there is no question but that they should be placed with the former.

Trochalopteron ellioti ellioti Verreaux.

Twenty-eight specimens, Washan, Tachienlu, Yachiakun, Tachiao, and Cheto, western Szechwan, and Changyanghsien, Hsienshanhsien, Mafuling, Hsienshan, Kwangpow, Patung, Tanshuiya, and Hsientientze, Hupeh, all seasons.

Trochalopteron formosum Verreaux.

Three adults, two males and a female, taken at Washan, western Szechwan, 7,000 feet, October 31, 1908.

Trochalopteron canorum (Linné).

Ten specimens, both sexes from Ichang, Changyanghsien, and Hsienshanhsien, Hupeh, all taken in autumn and winter, and from Tsaikow, and Kiating, western Szechwan, taken in October, and November.

Ianthocincla maxima (Verreaux).

Eleven specimens, young and adult of both sexes, Shuowlow, Ramala Pass, Yachiakun, Kaoerhshan, Wulungshih, and Lanerhyingpa, western Szechwan, midsummer.

Ianthocincla cinereiceps Styan.

One adult female from Hsienshanhsien, Hupeh, December 19, 1907.

Pomatorhinus styani Seebohm.

Ten specimens, adults of both sexes, Ichang, Hsienshan, Changyanghsien, and Hsienshanhsien, Hupeh, all seasons.

Pomatorhinus macclellandi gravivox David.

Two specimens, adult ♂ and ♀, from Peiyangsze, and Mafuling, Hupeh, May 12, and June 6, 1907.

Dryonastes perspicillatus perspicillatus (Gmelin).

Ten specimens, adults of both sexes, Ituhsien, Kingaohsien, and Ichang, Hupeh, and Chungchowhsien, eastern Szechwan, all seasons.

Dryonastes sannio (Swinhoe).

Fifteen specimens, young and adult, both sexes, Changyanghsien, Ichang, and Putze, Hupeh, and Lungchi, and Kiating, Szechwan, all seasons.

Alcippe nipalensis hueti David.

Sixteen specimens, both sexes, Kiating, and Changshowhsien, Szechwan, autumn, winter, and spring.

Proparus cinereiceps (Verreaux).

Fifteen specimens adults of both sexes, from Hsienshanhsien, and Hochaping, Hupeh, and Makaling, Tachiao, and Washan, western Szechwan, all seasons.

This series shows considerable variation in the colors of the head and back, a variation principally seasonal though in slight degree due to individual differences; there is however not a single specimen that could be referred to *Proparus fucatus* Styan described from Ichang.

MOUPINIA POECILOTIS (Verreaux).

Four specimens, adults and immature of both sexes, Tachienlu, and Chinchihsien, western Szechwan, at altitudes ranging from 8,000 to 12,500 feet, August and October.

SCHOENIPARUS VARIEGATUS Styan.

One adult ♂ in worn plumage, Chinshihsien, western Szechwan, June 27, 1908.

Ogilvie-Grant considers this species the same as *Schoeniparus genestieri* (Oustalet), which has two years priority over Styan's name; but Sharpe retains both species in his Hand List of Birds. With but a single specimen we are not in a position to decide.

STACHYRIDOPSIS PRAECOGNITUS (Swinhoe).

Seven specimens, adults of both sexes, Hsienshanhsien, Hupeh, and Kiating, Washanhsien, and Nanchihsien, Szechwan, spring, autumn, and winter.

The one skin taken at Hsienshanhsien, December 28, 1907, is paler below, more grayish and less greenish olive, above, than any of the Szechwan specimens. Though very pale in color below it is still, however, yellowish, and can not, we believe, be referable to *S. davidi* Oustalet, which was described as "cinerascentibus" on the breast and abdomen, though it would seem to approach that form in some degree.

MYIOPHONEUS CAERULEUS (Scopoli).

Five adults, both sexes, Kweichowhsien, and Ichang, Hupeh, and Nitow, and Kiating, western Szechwan, December, March, and June.

MYIOPHONEUS TIBETANUS Madarász.

This very distinct species with a yellow bill and *no semiconcealed white markings* on the feathers of the rump and sides, was taken at Nachuka, 10,000 feet, Tachienlu, 7,500 to 10,000 feet, Washan, and Cheto, 10,000 feet, western

Szechwan; ten specimens including young and adults were secured in spring and summer, 1908.

Hartert having examined the type, pronounced it a young bird and synonymous with *M. temminckii temminckii* Vigors (Die vögel der paläarktischen fauna, p. 676).

Our series contains six fully adult breeding birds, taken between the dates of May 18 and August 24, and as none of these show even the slightest indication of white spots so conspicuous on the rump and sides of *M. temminckii* and *M. caeruleus*, we believe that Hartert was mistaken in his disposition of the species. *M. tibetanus* is moreover of a rather duller blue color generally than *M. temminckii*, and the shiny blue spots are smaller both above and below.

Heteroxenicus cruralis formaster, sub. sp. nov.

Four specimens, an adult male, two young males, and an adult female, Washan Mountain, western Szechwan, 9,000 to 10,000 feet, May 31 to June 4, 1908.

Type:—No. 51970 M. C. Z. adult ♂. Western Szechwan: Washan Mountain, 10,000 feet, May 31, 1908. W. R. Zappey.

Characters:— Very similar to true *H. cruralis* (Blyth) of the eastern Himalayas, but larger; the adult male with the blue parts much grayer blue, less indigo; the adult female, duller, more olivaceous, less russet-brown. Thus, the new form seems to be in general color like *H. sinensis* (Rickett) of northwestern Fukien (which we have not seen) but is larger and has the lores black as in true *H. cruralis*.

Measurements:— Type, adult ♂, wing, 73; tail, 47; tarsus, 34; culmen, 14. Adult ♀, Topotype No. 51973, wing, 70; tail, 45; tarsus, 32.5; culmen, 13.

Remarks:— This bird was found only on Washan Mountain, where it lived in the rhododendron thickets; it was shot with great difficulty. There is no doubt that it is very closely related to true *H. cruralis* on the one hand and to *H. sinensis* on the other, still it differs from both in its larger size, and from each in other slight characters; and we believe it must be regarded as representing a distinct subspecies.

Tesia grallator, sp. nov.

Plate 5, figs. 1, 2.

Type:—No. 51975 M. C. Z. adult ♀. Western Szechwan: Washan Mountain, 10,000 feet, May 31, 1908. W. R. Zappey.

Characters:— Similar to *T. castaneocoronata* (Burton) (Plate 5, fig. 3, *bill*) of the eastern Himalayas, but with a *very much* smaller bill (Plate 5, fig. 2) which is of a yellowish color throughout; (the two specimens of *T. castaneocoronata* examined have the maxilla dark brown); crown orange-rufous instead of hazel or chestnut; underparts slightly paler yellow, with a narrow band of olive-green spots across chest; eye-ring, showing most distinctly just before and just behind eye, bright yellow.

Measurements:— Type, adult ♀, wing, 50.5; tail, 24; tarsus, 23; culmen, 8.5.

Remarks:— This Tesia also kept itself closely concealed in the thickets of rhododendron on Washan and the type was the only individual seen during the all too short stay on this exceedingly interesting mountain.

Yuhina gularis yangpiensis Sharpe.

Two adults, male and female, taken together, on Washan, western Szechwan, at 8,000 feet altitude, October 27, 1908.

These skins agree exactly with Sharpe's description, and are very different from examples of true *Y. gularis* from the eastern Himalayas. We have however seen no specimens from Yünnan.

Yuhina diademata Verreaux.

Nine adults, both sexes, Hsienshanhsien, Changyanghsien, and Putze, Hupeh, and Nitow, and Washan, western Szechwan, all seasons.

Liothrix luteus luteus (Scopoli).

Twenty-four specimens, adults of both sexes, Hsienshanhsien, Hsienshan, Patung, and Changyanghsien, Hupeh, and Yachow, Lungchi, and Luluping, Szechwan, all seasons.

Conostoma aemodium Hodgson.

Three adult males, Washan, western Szechwan, taken at altitudes of from 8,000 to 10,000 feet, May and October.

Cholornis paradoxa Verreaux.

Four adult males, Washan, western Szechwan, 8,000 to 8,500 feet, May, 1908.

Suthora unicolor canaster, sub. sp. nov.

Two specimens, both males, Washan, and Yachiakun, western Szechwan, July and November.

Type:—No. 50709 M. C. Z. adult ♂. Western Szechwan: Washan Mountain, November 3, 1908. W. R. Zappey.

Characters:—Similar to true *Suthora unicolor* (Hodgson) (compared with specimens from Sikkim) but slightly smaller with a decidedly smaller bill; coloration grayer, the breast and chest much more ashy and less vinous, sides of head paler and grayer, forehead and forward part of crown pearly gray instead of vinous brown.

Measurements:—Type, adult ♂, wing, 88; tail, 101; tarsus, 30.5; culmen, 13. No. 50710, adult ♂, Yachiakun, western Szechwan, July 14, 1908, wing, 89; tail, 104; tarsus, 30; culmen, 13.5.

Suthora conspicillata David.

One adult ♂, Hsientientze, Hupeh, 6,000 feet, June 2, 1907.

Suthora alphonsiana Verreaux.

Three adults, two males and a female, Kiating, and Luluping, western Szechwan, June, and November.

Suthora webbiana suffusa (Swinhoe).

Twenty-three specimens, adults of both sexes, Ichang, Hsienshanhsien, Shantau, and Kunganhsien, Hupeh, and Changshowhsien, eastern Szechwan all seasons.

Suthora zappeyi, sp. nov.

Plate 4, fig. 2.

Seven specimens, adults of both sexes, all from Washan Mountain, western Szechwan, 8,500 to 10,000 feet, October, November, and May.

Type:—No. 50738 M. C. Z., adult ♂. Western Szechwan: Washan Mountain, 9,000 feet, November 3, 1908. W. R. Zappey.

Characters:—A medium sized species, with a small bill, much crested head, and of dull coloration. Back Mars brown; head and anterior lower parts gray; sides ecru-drab; flanks and under tail-coverts, drab.

Color:— Pileum mouse-gray; sides of face and neck smoke gray; back Mars brown; rump and upper tail-coverts drab; wings dusky margined with Mars brown; tail dusky narrowly edged with drab; throat and chest pale drab-gray; sides of breast ecru-drab; flanks and under tail-coverts drab; bill pale yellowish, more or less dusky at base of culmen (in dried skin).

Summer — May 31 — specimens are like autumnal ones, except in being duller in colors throughout with the plumage much closer, less fluffy.

Measurements:— Type, adult ♂, wing, 58.5; tail, 77; tarsus, 22; culmen, 7.5. Adult ♀ Topotype, No. 50743, wing, 57; tail, 79; tarsus, 22; culmen, 8.

Remarks:— This species, which we have named in honor of Mr. Zappey, was seen on Washan only, where it is probably resident. It occurred in fair numbers both in spring, and early summer, and in autumn.

TROGLODYTIDAE.

Nannus troglodytes szetschuanus (Hartert).

Ten specimens, adults of both sexes and two young females. Ichang, Changyanghsien, and Hsienshanhsien, Hupeh, and Tachiao, and Wulungshih, western Szechwan, the latter at an altitude of 14,500 feet, all seasons.

Pnoepyga mutica, sp. nov.

Plate 4, fig. 1.

Type:— No. 51974 M. C. Z. adult ♂. Western Szechwan: Washan Mountain, 10,000 feet, June 3, 1908. W. R. Zappey.

Characters:— Somewhat similar to *P. squamata* (Gould) of the Himalayas, the upper parts very similar, the under parts much darker, the dusky centres of the feathers much more extended and the white borders much narrower and nearly or quite disappearing on the feathers of the sides and flanks; the pronounced buffy suffusion of the whole under parts of *P. squamata* is, except for a light buffy wash on the low belly, wanting in the Washan bird.

Color:— Whole upper parts, including wings and tail, Prout's brown, each feather of the head and back with a small terminal spot of tawny; throat plain white; chest and breast, to middle of abdomen with each feather dusky gray in the middle and white around the edges, producing a regular scale-like appearance; flanks and under tail-coverts dull Prout's brown, the feathers tipped with

brownish white; bill dark brown, yellowish white at base of lower mandible; legs and feet brown.

Measurements:—Type adult ♂, wing, 61; tail, 17; tarsus, 25.5; culmen, 11.5.

Remarks.—The unique specimen of this extraordinary little bird was secured almost by accident. It was on the ground, under the dense, all but impenetrable masses of rhododendron that cover the high sides of Washan, when a slight movement of the bird attracted Mr. Zappey's attention.

CINCLIDAE.

Cinclus cinclus cashmeriensis Gould.

One female Tachienlu, western Szechwan, 9,000 feet, September 30, 1908.

Cinclus pallasii souliei Oustalet.

Twenty-two specimens, young and adults of both sexes, Ichang, and Changyanghsien, Hupeh, all seasons.

TURDIDAE.

Planesticus merula mandarinus (Bonaparte).

Sixteen specimens, adults and young of both sexes, Ichang, and Changkowhsien, Hupeh, and Omeihsien, Hochianghsien, and Kiating, western Szechwan, all seasons.

Planesticus castanea gouldi (Verreaux).

Sixteen specimens, adults and young of both sexes, Tachienlu, and Tachiao, western Szechwan, midsummer.

Planesticus kessleri (Prjevalsky).

Four adults, two males and two females, western Szechwan: Tachienlu, 13,500 feet, Ramala Pass, 15,000 feet, Lanerhyingpa, 14,000 feet, and Kaoerhshan, 15,000 feet, July, and August, 1908. This fine bird was found only in the highest grass-lands, and was very rare even in those regions.

Psophocichla aurita (Verreaux).

One adult male, Kiating, western Szechwan, November 28, 1908.

Oreocincla aurea (Holandre).

One adult male, Ichang, Hupeh, April 30, 1907.

Oreocincla dauma socia, sub. sp. nov.

Two specimens, male and female adults, Tachienlu, western Szechwan, 9,000 feet, September 28, 1908.

Type:— No. 51177 M. C. Z. adult ♂. Western Szechwan: Tachienlu, 9,000 feet, September 28, 1908. W. R. Zappey.

Characters:— Similar to true *O. dauma* (Latham) of the Himalayas, and with twelve tail-feathers; but smaller, much darker in general coloration, with all the black markings of the feathers wider and the ochraceous markings narrower; underparts more ochraceous or buff-yellow, less whitish; under tail-coverts wholly buff-yellow; pileum much darker, the feathers, except for the ochraceous spot on each, black instead of brown.

Measurements:— Type, adult ♂, wing 138; tail, 95.5; tarsus, 34.5; culmen, 22. Adult ♀ No. 51176. Topotype, wing, 135; tail, 90; tarsus, 32; culmen, 22.

Remarks:— Like so many other Himalayan birds, *Orcocincla dauma* has a well-marked subspecies in the high mountains of western China. It must be either very rare or very retiring in its habits as Mr. Zappey saw but the two collected and we can not find that any other collector has ever taken it in this general region or in eastern Tibet where it should also occur.

Turdus cardis lateus Thayer & Bangs.

Bull. M. C. Z., May, 1909, 52, p. 140.

Four specimens, three adult males and a young male in nestling plumage, Ichang, Hupeh, April, June, and July.

This subspecies which is a well-marked form, easily separated from true *T. cardis* of Japan, was found only at Ichang where it was breeding. Mr. Zappey was away from Ichang in May, otherwise from April to July he occasionally saw or heard this thrush. He states that he might easily have secured additional specimens had he anticipated that it would not occur elsewhere.

Turdus naumanni (Temminck).

Twenty-eight specimens, Ichang, Ituhsien, and Changyanghsien, Hupeh, winter, and early spring.

Turdus ruficollis ruficollis (Pallas).

Two males, one taken at Ichang, March 22, 1907, the other a bird with but one leg and an old injury to one wing, was shot at Yachiakun, western Szechwan, 10,000 feet altitude, July 19, 1908. The partially disabled individual, which of course had been prevented from migrating northward in the spring, was in full breeding plumage.

Turdus fuscatus (Pallas).

Eleven specimens, Ichang, Changyanghsien, and Tawan, Hupeh, and Washan, and Wanhsien, Szechwan, winter, and early spring.

Petrophila solitarius solitarius (Linné).

Thirteen specimens, adults of both sexes, Ichang, Changyanghsien, Nantow, and Hsienshan, Hupeh, and Waszekow, Wanhsien, Luchow, Foochow, and Luitingchiao, Szechwan, all seasons. Several males — three or four — have more or less ferruginous mixed in the blue of the belly and under tail-coverts, thus approaching *P. solitarius philippensis* (Müll.).

Laiscopus collaris nipalensis (Hodgson).

One, young male just beginning to assume mature plumage, Cheto, western Szechwan, 13,500 feet, August 30, 1908.

Aprunella immaculata (Hodgson).

One adult male, Washan, western Szechwan, October 28, 1908.

Prunella strophiata multistriatus (David).

Five specimens, young and adults, Ramala Pass, Yachia, and Shuowlow, western Szechwan, 10,000 to 15,500 feet, midsummer.

Enicurus sinensis Gould.

Twenty-five specimens, adults of both sexes, Ichang, Yangchiatamiao, Yangchaho, Tatung, Chiliping, Chilitoyeh, Kwangpow, Hsienshan, Hsienshanhsien, and Changyanghsien, Hupeh, and Yachow, and Luluping, western Szechwan, all seasons.

Microcichla scouleri (Vigors).

Nine specimens, adults of both sexes and one young female, Ichanghsien, Hsienshanhsien, Tawan, Changyanghsien, Ichang, and Tanshuiya, Hupeh, and Washan, western Szechwan, all seasons.

Chimarrhornis leucocephala (Vigors).

Thirty-four specimens, both sexes, Ichang, Ichanghsien, Hsienshanhsien, and Changyanghsien, Hupeh, and Washan, Cheto, Motuimien, Tsaikow, Tachienlu, and Tachiao, western Szechwan.

Phoenicurus hodgsoni Moore.

Two adult males, Ichanghsien, Hupeh, February 4, 1909, and Kiating, western Szechwan, December 18, 1908.

Phoenicurus auroreus auroreus (Pallas).

Thirty-nine specimens, adults and young of both sexes, Ichang, Kwangpow, Showlungtu, and Hsienshanhsien, Hupeh, and Nachuka, Washan, and Kiating, western Szechwan, all seasons. Mature birds and two nearly full grown young in spotted plumage, were taken August 12, and 14, at Nachuka, 10,000 feet altitude.

The recently described *Phoenicurus auroreus filchneri* (Parrot), if really distinct, has probably a slightly different range; at all events our birds are referable to true *auroreus*. The wing in our largest males not exceeding 75 mm. and in the females not exceeding 72 mm., breeding birds are no larger than those taken in winter.

Phoenicurus frontalis Vigors.

Seven specimens, adults of both sexes, and one young male in spotted plumage, Washan, Yachiakun, and Yachow, western Szechwan, all midsummer, except one male taken December 3.

Phoenicurus schisticeps (Gray).

Five specimens, two adult males, one adult female, and two young males in spotted plumage, Ramala Pass, Shuowlow, and Wulungshih, western Szechwan, 12,500 to 15,000 feet, midsummer.

Rhyacornis fuliginosa fuliginosa (Vigors).

Forty specimens, young and adults, both sexes, Ichang, Changyanghsien, Hsienshanhsien, Showlungtu, Pinshinpow, and Kwatzeling, Hupeh, and Washan, Tachienlu, Tsaikow, Suifu, and Lungchi, Szechwan, all seasons.

Cyanosylvia suecia robusta (Buturlin).

Two males, Ichang, Hupeh, October 9, and November 1, 1907.

Hodgsonius phoenicuroides (Hodgson).

Eight specimens, adults of both sexes and young males, Chetzekow, Hupeh, and Washan, and Tachienlu, western Szechwan, spring, and summer.

Calliope davidi Oustalet.

Seven specimens, adults of both sexes, Yachiakun, and Lanerhyingpa, western Szechwan, 12,000 to 14,000 feet altitude, midsummer.

Ianthia cyanura (Pallas).

Twenty specimens, both sexes, Ichang, Kwatzeling, Hsienshanhsien, and Changyanghsien, Hupeh, and Kungyahsien, Shuowlow, Omeihsien, and Kiating, Szechwan, mostly winter, and early spring, though there is one female taken at Shuowlow, August 22, that is in very much abraded plumage.

Copsychus saularis (Linné).

Twelve adults, both sexes, Ichang, Changyanghsien, Kwangpow, and Shihtowya, Hupeh, and Hochiang, Szechwan, all seasons.

Copsychus saularis undoubtedly divides into a number of geographic races, as partly indicated by Sharpe in the Catalogue of the birds in the British Museum; many of these have received names. The Chinese and Indian birds differ somewhat and may have to be recognized, but we have far too little material at our command to attempt the subdivision.

Pratincola torquata prjewalskii Pleske.

Nine specimens, adults of both sexes and young males in autumn plumage. Ichang, Tawan, Chetzekow, and Hsientientze, Hupeh and Washan, western Szechwan. Six of these — five males and a female — were taken during the breeding season, from late April to the middle of June; the other three are young

males taken in September, and October and may have been migrants, though they appear to belong to the same form as the others.

It is with some hesitation that we refer these breeding birds from central and western China to *P. t. prjewalskii*, as they are rather smaller than that form, judged by the measurements given by Hartert in Die vögel der paläarktischen fauna. On the other hand they are too large to be placed with *P. t. stejnegeri* Parrot.

It is probable that they are about intermediate between the two, though perhaps nearer *P. t. prjewalskii* than to *P. t. stejnegeri*.

Oreicola ferrea haringtoni Hartert.

Five specimens, adults of both sexes, Tawan, Hsientientze, and Kwangpow, Hupeh, and Luluping, western Szechwan, spring, and summer.

SYLVIIDAE.

Locustella lanceolata (Temminck).

Four females, Ichang, Hupeh, September, October, and November.

Anteliocichla bistrigiceps (Swinhoe).

Two adults, male and female, Ichang, Hupeh, September, and October.

Anteliocichla agricola concinens (Swinhoe).

One adult male, in rather worn breeding plumage, Hsientientze, Hupeh, 5,500 feet, June 3, 1907.

Acrocephalus arundinaceus magnirostris (Swinhoe).

Five adults, both sexes, Ichang, Hupeh, June. These birds were breeding in the reed-beds of the river, and are in rather worn plumage. They appear to represent this form and not *A. inexpectatus;* the wing in the male is well over 80 mm. and the 2nd primary falls between the 3rd and 4th in length; the color of the upper parts moreover, is decidedly olive-brown.

We, however, recognize Swinhoe's name for the Chinese bird, separating it from the Japanese *A. arundinaceus orientalis* (Temminck and Schlegel) on account of its decidedly heavier bill and slightly larger size.

ACROCEPHALUS INEXPECTATUS Berezowski & Bianchi.

One adult male, taken at Ichang, Hupeh, October 8, 1907. This individual has the wing, 76 mm.; tail 61.5; tarsus, 27.; culmen, 17. The second primary falls between the 4th and 5th; and the color of the upper parts is a rich russet-brown. The specimen, therefore, agrees exactly with the description of Berezowski and Bianchi and is undoubtedly a migrant of the rather more northwestern species.

DUMETICOLA[1] BRUNNEIPECTUS (Blyth).

Nine specimens, adults of both sexes, Hsientientze, Hupeh, and Washan, western Szechwan, May, and June. All were taken at altitudes of between 6,000 and 8,000 feet.

Two nests with sets of eggs — one of two and the other of four — were secured May 31 and June 6, and in each case the female parent was also taken.

Our skins belong apparently to *D. brunneipectus* rather than to *D. russulus* (Slater), but we have had no specimens of the latter for comparison.

CISTICOLA CISTICOLA TINTINNABULANS (Swinhoe).

Two males, Kiating, and Hochianghsien, Szechwan, April 22, and May 6.

OREOPNEUSTE SUBAFFINIS (Ogilvie-Grant).

Ten specimens, adults of both sexes, Hsientientze, Tawan, and Showlungtan, Hupeh, and Kiating, Washan, and Tachienlu, Szechwan, at altitudes ranging from 5,000 to 8,000 feet, spring and summer. The one skin from Kiating which is in low country, was taken November 18, 1908, and is the only specimen in autumnal plumage.

A nest and set of four eggs was taken together with the female parent at Washan, 6,000 feet altitude, May 31, 1908.

OREOPNEUSTE AFFINIS (Tickell).

At Yachiakun, western Szechwan, September, 1908, at an altitude of 13,500 feet Mr. Zappey collected one male (probably young in first autumnal plumage) that is very unlike any in the series of *O. subaffinis* even the single autumnal one from Kiating. This specimen we can not distinguish in any way from skins of *O. affinis* from Shillong, India, with which we have carefully compared it.

[1] This genus is unquestionably quite distinct and must be recognized as different from Tribura.

It can be separated at once from *O. subaffinis* by the lemon-yellow underparts, under wing-coverts, and superciliaries; by its darker more olive-green back, and by the smaller amount of black on the lower mandible. It was probably a stray migrant.

It does not seem possible that it can be *O. bianchi* Sharpe (originally described by Berezowski and Bianchi as *O. davidi*) which we consider, though without specimens, to be much nearer to, if not the same as, *O. subaffinis*.

Oreopneuste fuscatus (Blyth).

Eight specimens, both sexes, Ichang, Hupeh, autumn — September 27 to November 28 — and one killed March 22.

Oreopneuste armandi (Milne Edwards).

Three adults, one male, two females, Tachienlu, western Szechwan, 9,000 to 10,000 feet, July.

Reguloides maculipennis debilis, sub. sp. nov.

Two adult females, western Szechwan; Kiating, November 26, and Luluping, November 8.

Type:— No. 52502 M. C. Z. adult ♀. Western Szechwan: Kiating, November 26, 1908. W. R. Zappey.

Characters:— Similar to true *R. maculipennis* (Blyth) of the Himalayas, but head mouse-gray instead of brownish olive; back bright olive-green instead of yellowish or greenish olive; throat paler, grayish white instead of dull drab-gray; belly paler and purer yellow — pale sulphur-yellow, instead of dull olivaceous maize-yellow.

Measurements:— Type, adult ♀, wing, 48; tail, 33; tarsus, 16; culmen, 7.

Remarks: — This is another very distinct west China subspecies of a Himalayan species. It probably breeds in the coniferous forest on Washan and perhaps in other parts of this elevated region, although it was not taken during the breeding season.

Reguloides pulcher (Blyth).

Three specimens, two males and a female all adults, Washan, Yachiakun, and Tachiao, western Szechwan, 11,000 to 12,000 feet, June, and July.

Reguloides proregulus (Pallas).

Twenty-three specimens, both sexes, Ichang, Chetzekow, Hsienshan, and Hsienshanhsien, Hupeh, and Kiating, Luluping, and Washan, Szechwan. All seasons, during the breeding season, however, all the places were of high altitude — 7,000 to 10,000 feet.

Reguloides superciliosus (Gmelin).

Fifteen specimens, both sexes, Ichang, Hsientientze, and Kwatzeling, Hupeh, autumn, and spring as late as May 10.

Reguloides mandellii Brooks.

One adult male, Lianghokow, western Szechwan, 12,000 feet, September 8, 1908.

Acanthopneuste borealis (Blasius).

Two males, Ichang, and Mafuling, Hupeh. September 25, and May 12.

Acanthopneuste plumbeitarsus (Swinhoe).

One adult female, Ichang, Hupeh, October 6.

Acanthopneuste magnirostris (Blyth).

Ten specimens, both sexes, Hsienthen, Wansow, Chetzekow, and Patung, Hupeh, and Tachienlu, Washan, and Yachiakun, Szechwan, spring, and summer.

Acanthopneuste lugubris (Blyth).

One adult male, Luluping, western Szechwan, May 13, 1908.

Acanthopneuste coronata (Temminck).

One adult male, Wanhsien, eastern Szechwan, April 2, 1908.

This is probably a very rare, or even an accidental migrant, so far inland. It is, however, a perfectly typical example of the species.

Acanthopneuste trochiloides (Sundeval).

Ten specimens, adults of both sexes, and one young male in nestling plumage (August 8), Hsientientze, Kwangpow, Hongchikow, Hochaping, Hupeh, and Nachuka, and Tsaikow, Szechwan, spring, and summer. Taken only at altitudes ranging from 5,000 to 10,000 feet during the breeding season.

Horornis fortipes davidiana (Verreaux).

Eight specimens, adults of both sexes and one young male, Ichang, Hsientientze, Hsienshanhsien, and Changyanghsien, Hupeh, and Kiating, Szechwan. All seasons; breeding specimens at high altitudes only, from 5,000 to 5,500 feet.

Neornis acanthizoides acanthizoides (Verreaux).

Eight specimens, adults of both sexes, Kiating, Washan, and Chungchowhsien, western Szechwan, winter, spring and summer.

Neornis flavolivacea intricatus Hartert.

Four specimens, adults of both sexes, Washan, Tachienlu, Yachiakun, and Lianghokow, western Szechwan, 10,000 to 13,000 feet, midsummer.

Neornis cantans canturianus (Swinhoe).

One adult male, Hsientientze, Hupeh, 5,500 feet, June 2, 1907.

Suya crinigera Hodgson.

Eight specimens, both sexes, Hsienshan, Nanyangho, and Patunghsien, Hupeh, and Kiating, Chinkowno, and Nashanhsien, Szechwan. This series includes skins in spring and summer plumage with black bills and comparatively short tails; and also examples taken in autumn and winter with pale bills, comparatively long tails, and considerably more reddish brown above with dusky markings on the throat and breast.

Prinia inornata exter, sub. sp. nov.

Plate 5, figs. 4–5.

Six specimens, adults of both sexes, Nanchihsien, Hokow, and Kiating, Szechwan, spring, autumn, and winter.

Type:— No. 52580 M. C. Z. adult ♂ in breeding plumage. Western Szechwan: Hokow, May 4, 1908. W. R. Zappey.

Characters:— By far the darkest race of *P. inornata*. In summer plumage the upper parts are of a shade about between olive and hair-brown; the under parts strong buff. In winter plumage the upper parts vary from tawny olive to raw umber and the under parts are clay color. It is therefore a very much darker bird than either *P. inornata inornata* Sykes of India or *P. inornata exten-*

sicauda (Swinhoe) of Amoy and southeastern China. These two are not very different in color, the upper parts ranging, in summer plumage, from drab to wood brown; and the same parts in the winter plumage are about ochraceous cinnamon.

Measurements:— Type adult ♂, summer plumage, wing, 51; tail, 67; tarsus, 21; culmen, 10.5. No. 52578, adult male from Kiating, western Szechwan, in winter plumage, wing, 50.5; tail, 89; tarsus, 22; culmen, 10.5.

Remarks:— We can not find that this dark, well-marked form of *P. inornata* has been named, although it seems probable that Dr. Anderson's Yünnan specimens would be referable to it. The seasonal differences are the same as in other members of the genus, but in both plumages it is easily distinguished from any other of the subspecies by its much darker, deeper coloring.

LANIIDAE.

Lanius bucephalus Temminck & Schlegel.

Three specimens, an adult male and two females, Ichang, Hupeh, October 29, and January.

Lanius tephronotus (Vigors).

Sixteen specimens, young and adults, of both sexes, Tachienlu, Nachuka, Lanerhyingpa, Yachiakun, Cheto, Washan, and the Ramala Pass, Szechwan, at altitudes ranging from 8,000 to 15,000 feet, midsummer.

Lanius schach schach Linné.

Nineteen specimens, adults of both sexes, Changkowhsien, Kingaohsien and Ichang, Hupeh, and Luchow, Suifu, and Kiating, Szechwan, all seasons, though mostly in winter.

Lanius lucionensis Linné.

Twenty-seven specimens, young and adults, both sexes, Ichang, Hsienshan, and Fangshen, Hupeh, spring, and summer.

PARIDAE.

Penthestes affinis (Prjevalsky).

Four adults, both sexes, Lianghokow, Yachiakun, Shuowlow, Tongolow, western Szechwan, at altitudes ranging from 11,000 to 14,000 feet, midsummer.

Penthestes hypermelaena (Berezowski & Bianchi).

Seven specimens, both sexes, Hsienshanhsien, Mafuling, Fonghsien, and Chetzekow, Hupeh, at altitudes ranging from 5,000 to 7,000 feet, winter and spring.

Penthestes dejeani (Oustalet).

One pair of adults, taken at Nachuka, western Szechwan, at 12,000 feet altitude, August 14, 1908.

While we hope that our determination of the three species of Penthestes is correct we must admit that our material for comparison is wholly inadequate.

Lophophanes dichroides Prjevalsky.

Nine adults, both sexes, Tachiao, Tongolow, Shuowlow, Wulungshih, and Washan, western Szechwan, 9,000 to 14,500 feet, summer, and autumn.

Periparus ater aemodius (Blyth).

One adult male, Hsienshanhsien, Hupeh, 5,500 feet, December 10, 1907.

Periparus rufonuchalis beavani (Jerdon).

Sixteen specimens, both sexes, Washan, Shuowlow, Tongolow, Wulungshih, and Ramala Pass, western Szechwan, 8,000 to 14,500 feet, summer, and autumn.

This series appears wholly referable to *beavani* and not to *poecilopsis* Sharpe from Yünnan; the latter compared with the former is described as much paler below.

Pardaliparus venustulus (Swinhoe).

Thirty-two specimens, young and adult of both sexes, Hsientientze, Ichang, Hsienshan, Mafuling, Kwatzeling, Nochaping, and Fangshen, Hupeh, all seasons.

Parus major tibetanus Hartert.

Perfectly characteristic examples of this form with an extreme amount of white in the tail, were taken in western Szechwan at Tachienlu, 9,000 feet, Nachuka, 10,000 feet, and Kiating in midsummer. Seven skins including one young ♂ and one young ♀, and adults of both sexes being secured. At Omeihsien, Hochiang, Lungchi, and Luluping seven skins including young and adults were taken, some of which are variously intermediate though all are nearer *tibetanus*, than the next form.

PARUS MAJOR ARTATUS Thayer & Bangs.

Bull. M. C. Z., May, 1909, 52, p. 140.

This recently described form occupies the very central part of China.

Twenty-nine specimens including young and adults, were taken, at all seasons of the year at Ichang, Hsientientze, Chiliping, Kwangpow, Changyanghsien, and Hsienshanhsien, Hupeh.

PARUS MONTICOLA MONTICOLA (Vigors).

Ten adult specimens, both sexes, from Ichang, Chetzekow, Kwangpow, and Hsienshanhsien, Hupeh, and Omeihsien, Kiating, and Washan, western Szechwan, all seasons.

AEGITHALISCUS CONCINNUS (Gould).

Thirty specimens, young and adults, both sexes, from Ichang, Yangchiatamiao, Changyanghsien, Hsienshanhsien, and Hsienshan, Hupeh, and Kiating, Chienweihsien, Wushanhsien, Nanchihsien, Chungking, Luchow, and Chungchowhsien, Szechwan, all seasons.

AEGITHALISCUS BONVALOTI (Oustalet).

One male, not in fully mature plumage, shot at Shuowlow, western Szechwan, 14,000 feet altitude, August 21, 1908.

AEGITHALISCUS FULIGINOSUS (Verreaux).

Fourteen specimens, adults of both sexes, Hsientientze, Hsienshanhsien, and Fonghsien, Hupeh, winter, and spring.

AEGITHALUS GLAUCOGULARIS (Gould).

Twenty specimens, adults of both sexes, from Ichang, Hupeh, taken at all seasons.

These skins are all referable to true *glaucogularis* and not at all to *calvus* (Pleske) which is said to range through Szechwan to central China.

REGULIDAE.

SYLVIPARUS MODESTUS OCCULTUS, sub. sp. nov.

Type:—No. 50745 M. C. Z. adult ♀. Western Szechwan: Kiating, November 15, 1908. W. R. Zappey.

Characters:—Similar to true *S. modestus* Burton of the Himalayas, but much grayer, and less greenish in color throughout: upper parts dark, grayish olive-green, much darker, more grayish, less brownish than in true *S. modestus*; under parts dull, grayish pea-green, very different from the pale yellowish olive-green under parts of true *S. modestus*.

Measurements:—Type adult ♀, wing, 54; tail, 51.5; tarsus, 15; culmen, 7.

Remarks:—Although we have but a single example this is so different in general color from Himalayan skins that it represents without doubt an easily recognized Chinese subspecies.

SITTIDAE.

Sitta sinensis Verreaux.

Twelve specimens, adults of both sexes from Ichang, Kwatzeling, Fonghsien, Putze, Hsienshanhsien, and Changyanghsien, Hupeh in altitude up to 6,500 feet, all seasons.

Sitta montium La Touche.

Five specimens, four adults of both sexes and one young, Nachuka, 12,000 feet, Ramala Pass, 12,000 feet, and Yachow, western Szechwan, midsummer.

The differences, as pointed out by La Touche, distinguish a mountain from a lowland form of the Chinese nuthatch stand out so strongly in our series and are of such a nature that taken together with the distribution, would indicate specific rather than subspecific rank for the two forms.

Sitta przewalskii Berezowski & Bianchi.

One adult female shot Aug. 18, 1908, at Shuowlow, western Szechwan, 14,000 feet.

This specimen, though a female has a wholly blue-black crown and agrees minutely with the original description of the type, an adult male.

CERTHIIDAE.

Certhia familiaris khamensis Bianchi.

One adult ♂, Lianghokow, western Szechwan, 13,000 feet, September 7, 1908. This specimen in fine fresh plumage, apparently belongs here, and is not referable to *C. familiaris bianchii* Hartert recorded from northern Szechwan.

Certhia himalayana yunnanensis Sharpe.

Three adults, two females and a male Ramala Pass and Nachuka, western Szechwan, 12,000 to 13,000 feet altitude, August.

Tichodroma muraria (Linné).

Four adults, both sexes, Ichang, Hupeh, and Kiating, Washan, and Kungyahsien, western Szechwan, winter.

ZOSTEROPIDAE.

Zosterops simplex Swinhoe.

Four adults, both sexes, taken in spring, and summer at Hsienshan, and Kwatzeling, Hupeh.

These specimens, while probably referable to *Z. simplex* rather than to *Z. mussoti* Oustalet of Szechwan, which was not observed by Mr. Zappey, show some signs of being intermediate; they have smaller bills, and the black line from the side of the bill to and below the eye is more distinct than in *Z. simplex;* but the yellow of the throat does not extend far backward, and the color agrees with that of *Z. simplex.*

DICAEIDAE.

Dicaeum ignipectus cyanonotum Styan.

Two adult males, one from Hsienshan, Hupeh, June 7, 1907, the other Wahsien, western Szechwan, April 2, 1908.

This well-marked form appears to be rare, and the two specimens taken were the only ones seen.

NECTARINIIDAE.

Aethopyga dabryi (Verreaux).

Twenty-one specimens, adults of both sexes, Hsientientze, Mafuling, Wantaoshan, Patung, Hongsurkow, Hupeh, and Washan, western Szechwan, all taken in May, and June, at altitudes up to 10,000 feet.

MOTACILLIDAE.

Motacilla alba occularis (Swinhoe).

Eight specimens, both sexes, Ichang, Hupeh, and Kiating, Szechwan, all taken in September, October, and November.

Motacilla alba leucopsis (Gould).

Twenty specimens, adults and young in first winter plumage, of both sexes, Ichang, Hupeh, January, March, September, and October.

Motacilla alba baikalensis (Swinhoe) should occur in this general region in winter, but Mr. Zappey did not take it. All adult birds in our series are certainly referable to *M. alba leucopsis*, and most of the young ones have the gray of the back more or less marked with black, and we consider all one and the same form.

Motacilla alba hodgsoni (Blyth).

Eight specimens, adults of both sexes, and two young in nestling plumage, Washan, Hochianghsien, Wanhsien, Chiangchinghsien, and Tachienlu, western Szechwan, April, May, July, and October.

The two nestlings — nearly full-grown — were shot at Tachienlu, 9,000 feet altitude, July 23, 1908.

Motacilla boarula melanope (Pallas).

Nineteen specimens, adults and young in winter plumage of both sexes, Ichang, Kweichowhsien, Hongchikow, Kwangpow, Shuiyuehtze, and Chiliping, Hupeh, and Kiating, Tachienlu, Washan, and Tsaikow, Szechwan, all seasons.

A nest and clutch of eggs was taken, together with the male parent bird, at Washan, western Szechwan, 6,000 feet altitude, June 6, 1908.

Budytes citreola (Pallas).

One fine male in full spring plumage, Chiangaohsien, Szechwan, April 28, 1908.

Budytes flavus borealis (Sundeval).

Two specimens were taken at Ichang, Hupeh, an adult male, September 14, 1907, and an immature male, October 22, 1907.

BUDYTES FLAVUS SIMILLIMUS (Hartert).

Four males, two in adult and two in immature plumage, Ichang, Hupeh, October 4, Luchow, April 26 (two adult males) and Yachiakun, Szechwan, September 5, 1908.

DENDRONANTHUS INDICUS (Gmelin).

One female, Ichang, Hupeh, October 12, 1907.

ANTHUS HODGSONI Richmond.

Thirty-one specimens, young and adults, both sexes, Ichang, Hsienshan, Hsientientze, Chetzekow, Showlungtu, Hupeh, and Washan, Luchow, and Kiating, Szechwan, all seasons.

A two thirds grown nestling was taken at Washan, Szechwan, at 8,000 feet attitude, with its male parent, May 31, 1908.

ANTHUS RICHARDI Vieillot.

Seven specimens, adults of both sexes and one young male, Ichang, Hupeh, and Luchow, Nanchihsien, Hongyalehsien, and Chungking, Szechwan, April, September, October, and December. A young male with some of the feathers of the nestling plumage remaining especially on the shoulders, head, and rump was shot at Ichang, October 19, 1907.

ANTHUS CERVINUS (Pallas).

Four specimens, both sexes, Ichang, Hupeh, and Chiangchinghsien, Hochianghsien, and Wanchihsien, Szechwan, April, and September.

ANTHUS ROSEATUS Blyth.

Fourteen specimens, adults and young of both sexes, Ichang, Showlungtan, and Shentungchow, Hupeh, and Yachiakun, Tachienlu, Suifu, Ramala Pass, Luchow, and Cheto, Szechwan, autumn, spring, and summer. In the breeding season it was found up to an altitude of 15,500 feet.

Young birds with much of the nestling plumage, were shot during August (16th, 30th) at from 13,500 to 15,500 feet altitude.

ANTHUS SPINOLETTA BLACKISTONI (Swinhoe).

Seven specimens, both sexes, Ichang, and Hsienshanhsien, Hupeh, March, and December.

ANTHUS SPINOLETTA JAPONICUS (Temminck & Schlegel).

Five specimens, both sexes, Ichang, Hupeh, and Washan, and Kiating, western Szechwan, February, March, October, and November.

ALAUDIDAE.

OTOCORIS ELWESI ELWESI Blanford.

Three specimens, adult male and female and nestling, nearly full grown, Lanerhyingpa, western Szechwan, 14,000 feet altitude, August 4, 1908.

This horned lark was found in the high grass-lands, of what is really eastern Tibet, but it must be very uncommon there, or at least local, in the breeding season, as one little family only was seen.

ALAUDA GULGULA GUTTATA Brooks.

Thirteen specimens, adults and young of both sexes, Ichang, Tawan, and Changyanghsien, Hupeh, and Lochichen, Washan, and Chiangchinghsien, Szechwan, all seasons.

We have compared this series with the greatest care with all material available including a series from Cashmir in the U. S. national museum, from which our Chinese birds do not appear to differ; *Alauda gulgula guttata* is without doubt the sky-lark of central and western China.

CALANDRELLA BRACHYDACTYLA DUKHUNENSIS (Sykes).

One adult male, Juchi, central Szechwan, April 20, 1908.

This skin, like those in the U. S. national museum, recorded from Shensi by Richmond, belongs to the larger more deeply colored eastern subspecies.

FRINGILLIDAE.

CHLORIS[1] SINICA (Linné).

Sixty-two specimens, adults and young, both sexes, Ichang, and Yangchiatamiao, Hupeh, and Kiating, Washanhsien, Hochinghsien, Juchi, Chiachiang, Luchow, and Lungchi, Szechwan. All seasons.

In the low lands this is one of the commonest of all Chinese birds, coming about the houses and in the groves that surround the temples.

[1] We see no necessity for using Ligurinus for Chloris as Sharpe does in volume 5 of the Hand list.

Eophona melanura melanura (Gmelin).

Thirty-four specimens, both sexes, Ichang, Ituhsien, Changhsien, Kunganhsien, and on the Yangtze near Shasi, Hupeh, all seasons.

This species was not found in Szechwan during the second years work.

Eophona melanura migratoria Hartert.

Three specimens, a male and two females all taken together at Ichang, April 30, 1907, are so small, and with such very small bills that they unquestionably belong to this northern form; they were probably migrating.

Coccothraustes coccothraustes japonicus (Temminck & Schlegel).

One pair, the only individuals of this species seen by Mr. Zappey were taken May 15, 1907, at Hongsurkow, Hupeh, at 6,000 feet altitude.

Fringilla montifringilla Linné.

Thirty-one specimens, both sexes, Changyanghsien, Hsienshanhsien, and Kwangpow, Hupeh and Washan, western Szechwan, late autumn, and winter.

Montifringilla nemoricola nemoricola (Hodgson).

Three specimens, an adult ♂ taken July 14, 1908 at Yachiakun, 14,000 feet altitude, and an adult ♀ and young ♀ in nestling plumage, August 30, 1908, at Cheto, western Szechwan, 13,500 feet altitude.

Passer montanus montanus (Linné).

Thirty-one specimens, both sexes, Ichang, Hsienshan, Changyanghsien, and on the Yangtze near Shasi, Hupeh, and Washanhsien, eastern Szechwan. The Tree sparrow appears to be found at low altitudes only, as none were taken at any height in the mountains.

Passer rutilans cinnamomeus (Gould).

Eight specimens, adults of both sexes, Tachienlu, Nachuka, and Lungchi, western Szechwan, all at high altitudes, up to 12,000 feet. Spring, and summer.

These skins are typical, agreeing exactly with examples from Sikkim and Manipur.

Passer rutilans rutilans (Temminck).

Fifteen specimens, both sexes, from Ichang, Hsienshanhsien, Fangshen, Mafuling, Wantaoshan, Nochaping, and Tanshuiya, Hupeh, and Omeihsien, western Szechwan, 3,000 feet altitude.

All of these skins are much nearer *rutilans* than *cinnamomeus*, some being quite like Japanese specimens; others however show indications of being intermediates, and the two forms without much doubt intergrade in west central China.

Judged solely by Mr. Zappey's experience, *rutilans* is a bird of lower altitudes than *cinnamomeus*; it is also more eastern, and *cinnamomeus* does not appear in its extreme form till the high mountains of western China are reached.

CARPODACUS ERYTHRINUS ROSEATUS (Hodgson).

Fourteen specimens, both sexes, Hsienshan, Hupeh, and Washan, Hochianghsien, Shuowlow, and Tachienlu, Szechwan, ranging in altitude up to 13,000 feet, all seasons.

CARPODACUS[1] DUBIUS Prjevalsky.

Fourteen specimens, young and adult of both sexes, Yachiakun, Tongolow, Ramala Pass, Shuowlow, and Wulungshih, western Szechwan, at altitudes between 12,000 and 15,000 feet. Summer, and autumn.

CARPODACUS PULCHERRIMUS (Moore).

Nineteen specimens, adults of both sexes, Yachiakun, Tachienlu, Ramala Pass, Lanerhyingpa, Nachuka, and Cheto, western Szechwan, at altitudes of from 10,000 to 15,000 feet, summer.

CARPODACUS EDWARDSI Verreaux.

Four adult females, Washan, and Tachiao, western Szechwan, at altitudes ranging from 8,000 to 12,000 feet; summer, and autumn.

CARPODACUS RHODOPEPLUS VERREAUXII David.

Three specimens, an adult female from Yachiakun, 14,000 feet, and an adult male and female, shot together at Lianghokow, western Szechwan, 12,000 feet, August 8, 1908.

The two females agree with the description of the type and also with those of later authors, all of which were based on the type.

The adult ♂ is in rather well-worn midsummer dress. It is decidedly smaller than males of *Carpodacus rhodopeplus rhodopeplus* (Vigors), but so far as color is concerned it differs very little from that form. It appears to be

[1] We see no advantage in recognizing such a poorly defined genus as Propasser.

paler, more rosy, less crimson on fore neck and breast, these parts being little darker than the belly; but this difference, very likely, is due to fading and abrasion as there is a suggestion of darker more crimson coloration about the chin and throat where the feathers are less worn.

The three skins afford the following measurements:—

No.	*Sex*	*Locality*	*Wing*	*Tail*	*Tarsus*	*Culmen*
50229	♂ ad.	Lianghokow	73.	65.	19.	11.
50230	♀ ad.	Lianghokow	71.	64.5	18.	11.
50231	♀ ad.	Yachiakun	74.	64.	18.5	11.

Carpodacus vinaceus Verreaux.

Six specimens, adults of both sexes, Wantaoshan, and Chetzekow, Hupeh, and Washan, and Kiating, western Szechwan, summer, and autumn.

Loxia curvirostra himalayensis Blyth.

One adult ♂, Washan, western Szechwan, October 27, 1908. This is the only time that Mr. Zappey observed crossbills though for a long time he was in regions where they might be expected to occur; the specimen collected was one of two that were feeding in the spruce forest.

Pyrrhula erythaca altera Rippon.

Twenty-one specimens, adult and young of both sexes, Hsienshanhsien, Mafuling, and Changyanghsien, Hupeh, from 5,000 to 6,000 feet altitude and Tachiao, western Szechwan, 12,000 feet altitude, all seasons. At Tachiao this bullfinch was quite common about the entrance to the cave in which Mr. Zappey was living and one or two were shot every morning during his stay there in September.

The numerous males differ very much as to the color of the under parts; this varies from rosy scarlet in some individuals to deep chrome in others, with the bulk of the series showing many intermediate shades of yellowish red or reddish yellow. The upper parts in the males are invariably clear slate-gray, and our bird is without doubt the same as the western Yünnan form named *altera* by Colonel Rippon.

Uragus sibiricus lepidus David & Oustalet.

Four adults, two males and two females, Nachuka, and Ramala Pass, western Szechwan; taken at altitudes of from 10,000 to 12,000 feet, in August, 1908.

Emberiza pusilla Pallas.

Thirty-nine specimens, both sexes, Ichang, Yangchiatamiao, Kwangpow, Changyanghsien, Hsienshanhsien, Kunganhsien, and Mafuling, Hupeh, and Foochow, Omeihsien, Kiating, Hochianghsien, Luluping, Wushanhsien, and Chiangchinghsien, Szechwan, winter, and spring.

Emberiza rustica Pallas.

Twenty-four specimens, Ichang, Hsienshanhsien, Kunganhsien, and Changyanghsien, Hupeh, winter, and early spring.

Emberiza fucata fucata Pallas.

One female, Ichang, Hupeh, September 29, 1907.

Emberiza elegans Temminck.

Thirty-two specimens, Hsienshanhsien, Changyanghsien, Kwangpow, Hochiaping, Tawan, Mafuling, Hsienshan, and Wantaoshan, Hupeh, and Kiating, Washan, and Luluping, Szechwan.

Most of these specimens were taken in winter and early spring, but in 1907, at Mafuling, Wantaoshan, and Hsienshan, examples in worn plumage were secured throughout May and as late as June 5, and again in 1908 the species was found at Washan from May 23 to June 8; these dates indicate that the birds were breeding.

Emberiza chrysophrys Pallas.

Five males, Ichang, Hsienshanhsien, and Changyanghsien, October, December, and January.

Emberiza aureola Pallas.

Seven specimens, both sexes, Ichang, Hupeh, all taken in autumn except one adult male taken April 30.

Emberiza spodocephala spodocephala Pallas.

This form winters, perhaps sparingly, in the region visited, and the series collected contains some undoubted adult males; some adult females, and young birds of both sexes in winter plumage we are unable satisfactorily to distinguish, but as the majority of adult males belong to the resident breeding subspecies, it is probable that the majority of females and young also belong there.

We refer to this form four skins including one adult ♂ taken at Shanghai in February, 1907, one adult ♂ from Ituhsien, Hupeh, January 31, 1908, and three specimens including an adult male from Kiating, western Szechwan, taken in November, and December.

Emberiza spodocephala melanops Blyth.

Twenty-two specimens, Ichang, Kwangpow, Hochiaping, Changkowhsien, Kwatzeling, and Hsienshanhsien, Hupeh, and Washan, western Szechwan, all seasons. Breeding birds were taken at Kwangpow, Hochiaping, Kwatzeling, and near Ichang, Hupeh, and at Washan, Szechwan. At the latter place two nests with sets of eggs were taken, June 3, 1908, together in both cases with the female parent bird. It is not difficult to separate the adult male of this resident form from adult males of *E. spodocephala spodocephala*, the fore neck and breast of *melanops* are olive-green instead of gray and its belly is brighter yellow.

Adult females can also usually be distinguished, but immature birds killed in winter are very puzzling and their identification is, we believe, largely empirical.

Emberiza cioides castaneiceps Moore.

Thirty-one specimens, both sexes, Ichang, Kwangpow, Kwatzeling, Hsienshanhsien, Patunghsien, Peimuping, and Changyanghsien, Hupeh and Yünyanghsien, Wanhsien, and Washan, Szechwan, all seasons.

Emberiza yunnanensis Sharpe.

Thirty-three specimens, young and adults of both sexes, Hsienshanhsien, Tawan, Kwangpow, Hsientientze, Changyanghsien, and Mafuling, Hupeh, and Tachienlu, Hwaliangmien, Washan, Luitingchiao, and Nachuka, Szechwan, all seasons.

A set of eggs together with the female parent was taken at Washan, western Szechwan, at 6,000 feet altitude June 7, 1908, and a full-fledged nestling in spotted plumage was shot at Tachienlu, July 7, 1908.

Melophus melanicterus (Gmelin).

One male, Kiating, western Szechwan, November 28, 1908. One other individual of this species was seen but not secured.

PLOCEIDAE.

Urolоncha squamicollis Sharpe.

Six specimens, adults of both sexes and one young male, Kiating, and Chiachianghsien, western Szechwan, and Changshowhsien, eastern Szechwan, April, and November.

STURNIDAE.

Spodiopsar cineraceus (Temminck).

Ten specimens, adults of both sexes, Changkowhsien, Ituhsien, and Ichang, Hupeh.

Spodiopsar sericeus (Gmelin).

Four specimens, both sexes, Ichang, Hupeh, and Kungyahsien, western Szechwan, October, and December.

Agropsar sturninus (Pallas).

Two specimens, male and female, Ichang, Hupeh, September 16, and 26, 1907.

Aethiopsar cristatellus (Linné).

Twenty-seven specimens, adults, of both sexes, Ichang, Hsienshan, Changkowhsien, Changyanghsien, Hupeh, all seasons.

ORIOLIDAE.

Oriolus diffusus Sharpe.

Thirteen specimens, both sexes, from Ichang, Patung, Hsientientze, and Hsienyuchtze, Hupeh, and Luluping, and Chinkowno, western Szechwan, spring, summer, and early autumn.

DICRURIDAE.

Chibia hottentotta brevirostris (Cabanis).

Eight adults, both sexes, Wantaoshan, Hsienshan, Fongshen, and Hsientientze, Hupeh, and Kwanerhyingpa, western Szechwan, May, June, and October.

A nest and clutch of two eggs was taken, together with the female parent bird at Hsienshan, Hupeh, on June 8, 1907.

The short-billed Chinese birds when compared with Indian examples seem to constitute a perfectly valid race.

Buchanga atra cathoeca Walden.

Eighteen specimens, adults and young of both sexes, Ichang, Peimuping, and Hsienshenshan, Hupeh, and Suifu, Szechwan, spring, summer, and autumn.

Buchanga leucogenys Walden.

Six adults, both sexes, Ichang, Shinshenshan, and Fongshen, Hupeh, and Luluping, Szechwan, May and June.

CORVIDAE.

Sitocorax pastinator (Gould).

Nine specimens, adults of both sexes Kunganhsien, Changkowhsien, Yangtze near Shasi, Hupeh, and Kiating, Hungyahsien, and Chiachianghsien, Szechwan autumn and winter.

Corvus corax tibetanus Hodgson.

One adult male, Shuowlow, western Szechwan, 12,500 feet altitude, August 21, 1908.

Corvus macrorhynchus levaillantii Lesson.

Thirteen specimens, adults of both sexes, Ichang, Changyanghsien, Hsientientze, Hsienshanhsien, Yangtze near Shasi, and Moshuiping, Hupeh, and Washan, western Szechwan, all seasons.

Corvus torquatus Lesson.

Ten specimens, both sexes, Ichang, and Changkowhsien, Hupeh, and Washan, and Chungchowhsien, Szechwan, all seasons.

Corvus corone orientalis Evermann.

One adult female, Washan, western Szechwan, November 6, 1908.

There is also in the collection a young crow from Tachienlu, western Szechwan at 10,300 feet altitude that we consider this species. It is wholly in nestling plumage and was about two thirds grown. It was taken July 13, 1908.

Coloeus neglectus (Schlegel).

One old female, Tachienlu, western Szechwan, 10,000 feet altitude, July 20, 1908.

This specimen is rather larger than any in a series of five in the collection of the Museum of comparative zoölogy from near Pekin. Its wing being, 240 mm. long, as contrasted with 231 mm. in the largest of the Pekin skins. Tachienlu is also well beyond the known range of *C. neglectus* and very probably more specimens would show that a large race of the Black jackdaw occupies this region as well as a large race of *C. dauuricus*. We, however, hesitate to make such a separation on a single specimen.

Coloeus dauuricus dauuricus (Pallas).

Three adults, one male and two females, Ituhsien, Hupeh, February.

Coloeus dauuricus khamensis Bianchi.

Six specimens, both sexes, including four adults and two young, Tongolow, and Tachienlu, western Szechwan, 10,000 to 12,000 feet altitude, July, and August.

This fine large form, originally described from Kham, Tibet, is easily distinguished from true *C. dauuricus* not only by greater size, but by the slightly different shade of its belly. Bianchi (Ann. Mus. St. Petersb., 1903, **8**, p. 11) first recorded the form under a *nomen nudum*, *C. major*, and three years later, when describing it, Bull. B. O. C., **16**, p. 68, used another name, *C. khamensis*. Sharpe, however, in the Hand List, gives both names, apparently overlooking the fact that they apply to one and the same form.

Nucifraga hemispila macella Thayer & Bangs.

Bull. M. C. Z., May, 1909, **52**, p. 140.

Two specimens, an adult male, the type, from Hsienshanhsien, December 11, 1907, and an adult female from Tachienlu, western Szechwan, September 23, 1908.

This form is only slightly different from the Himalayan bird, true *hemispila*. It is, however, smaller and has a shorter and thicker bill, but the pronounced character of the white spotting in the Chinese bird does not hold good when compared with a large series of Indian skins.

PICA PICA SERICEA Gould.

Thirteen specimens young and adults of both sexes, Ichang, and Changyanghsien, Hupeh, and Kiating, Luluping, and Washan, western Szechwan, all seasons.

PICA PICA BOTTANENSIS Delessert.

Two specimens, youngish male and female, Shuowlow near the Ramâla Pass, western Szechwan, at 12,500 feet altitude, August 22, 1908.

These birds were full grown and had wings and tail as in the adult; in the female most of the feathers of the back are of adult plumage; and in both, the lesser amount of white on the primaries is very evident. These specimens may be too immature to have acquired the wholly black back, but neither show any trace of a pale band on the rump.

CYANOPICA CYANA SWINHOEI Hartert.

Eleven specimens, adults of both sexes, Ichang, and Changkowhsien, Hupeh, all seasons.

UROCISSA ERYTHRORHYNCHA (Gmelin).

Twenty-seven specimens, adults of both sexes, Ichang, Kwangpow, Shihtowya, Hsienshanhsien, and Changyanghsien, Hupeh, and Yachow, Kiating, and Chungchowhsien, Szechwan, all seasons.

GARRULUS SINENSIS Swinhoe.

Twenty-seven specimens, adults of both sexes and one young female, Ichang, Changyanghsien, Hochaping, Shihtowya, Hsientientze, Hsienshan, and Hsienshanhsien, Hupeh, and Luchow, Changshowhsien, Nachuka, Washan, and Luluping, Szechwan, all seasons.

This series shows but little variation, except that certain specimens have more or less black streaking on the forehead and crown; and this variation occurs occasionally in various places.

BOANERGES, gen. nov.

Type:— *B. internigrans*, sp. nov.

Characters:— Similar to *Perisoreus* (*P. infaustus*) but bill *much* broader and more depressed basally, particularly the maxilla (bill but $\frac{2}{3}$ as high as broad at base); the commissural edges of maxilla flattened and flaring basally; the culmen

much more flattened especially basally; nasal tufts less copious and more bristly; tarsus relatively longer.

Color:— Wholly dark gray with black wings, tail, and head; bill mostly dull green.

Boanerges internigrans, sp. nov.

Plate 6.

Six specimens, adults of both sexes, Shuowlow, western Szechwan, 14,000 feet, August 22 and 23, 1908.

Type:— No. 52587 M. C. Z. adult ♂. Western Szechwan: Shuowlow, 14,000 feet, August 23, 1908. W. R. Zappey.

Color: — Head, including cheeks and chin, wings, and tail dull black; rest of body dull grayish slate color, the breast and chest somewhat flecked with black; bill dull light greenish, darker at base and along sides of culmen; tarsus and foot black.

Measurements: — Type, adult ♂, wing, 167; tail, 161; tarsus, 42.5; culmen, 26. No. 52591, adult ♀, topotype, wing, 165; tail, 155; tarsus, 40.5; culmen, 24.

Remarks: — Mr. Zappey met with this remarkable species only at Shuowlow where he found it in small numbers in the coniferous forest, behaving exactly, he tells us, like the Canada jay of North America.

Pyrrhocorax pyrrhocorax (Linné).

Eleven specimens, adults of both sexes and young, Tachienlu, and Cheto, western Szechwan, 9,000 to 12,000 feet, summer.

The Chough was abundant in the high mountains in western Szechwan but was not met with in Hupeh.

Graculus graculus (Linné).

Four adult males, Tachienlu, and Yachiakun, western Szechwan, 14,000 to 15,000 feet, summer.

The Alpine chough was decidedly rarer than the last species and occurred only at greater altitudes, from 14,000 feet or thereabouts, upward; still at these lofty elevations it was constantly seen flying about like a swallow and now and then settling in the villages to feed on Yak excrement.

MAMMALIA.

By Glover M. Allen.

The splendid collection of mammals made by Mr. Zappey in the Provinces of Hupeh and Szechwan numbers some 375 well-prepared skins, together with a few trade skins and several large skulls and horns. The lack of comparable material has made the determination of some of the species rather difficult especially in the case of the genera Epimys and Apodemus, of which a number of closely allied forms inhabit southeastern Asia. Although Père David collected with considerable thoroughness in parts of Szechwan, and later travellers have sent collections of mammals to Europe, there appear to be several species among the smaller rodents that have hitherto escaped notice. Of these, perhaps the most interesting are two very well-characterized species of voles belonging to the subgenus Eothenomys, and a very dark brown Craseomys, also apparently new, which is the most southeastern Asiatic species yet found, for voles seem to be few in southern China.

All measurements are in millimeters and colors are according to Ridgway's Nomenclature of colors.

BOVIDAE.

Budorcas tibetanus (Milne Edwards).

In the mountains at Lianghokow, western Szechwan, Mr. Zappey obtained a fine adult female and at Washan two young Takins. Milne Edwards (1868–'74) who figured this animal and described its skeleton at some length, considered it a race of *B. taxicolor* of the Mishmi Hills. Lydekker in the London Field (1908, **111**, p. 790) proposed the name *Budorcas taxicolor mitchelli* for a gray-colored female received by the British Museum from Szechwan, supposing it to represent a different race from the darker animal found in the same localities. Later, however, after comparison of specimens he (1908a, p. 795) reached the conclusion that the difference in color was merely sexual, and that *B. taxicolor* was specifically distinct from *B. tibetanus* of Szechwan. In a communication to the London Field, 19 March, 1910, **115**, p. 520, he further records a gray male from Szechwan, apparently indicating that the two color phases are independent of sex. The adult female secured by Mr. Zappey represents the gray phase.

Naemorhedus griseus Milne Edwards.

In his review of this genus, Pocock (1908, p. 173) has shown that the several varieties of Gorals described from southwestern China are, for the present at least, best referred to the one species, *N. griseus*, whose range is rather extensive in the highlands of that part of the country. A series of seven specimens, young and old, of both sexes, was collected by Mr. Zappey, and these show a fairly close agreement in color. Four were shot at Ichanghsien, one at Patunghsien, Hupeh, and two at Liuyang, in western Szechwan at an altitude of 7,000 feet. The variations shown by the Ichanghsien skins are quite as described by Pocock for specimens in the British museum from the same region, and I am unable to distinguish these from specimens taken in western Szechwan. The same variation in the horns described by Pocock is likewise present in the series studied. In adults from the same locality, there are some in which the horns curve sharply backward, and others in which they are straighter and nearly in the same plane with the frontal outline. These differences are rather striking at first but seem to be wholly individual.

Capricornis argyrochaetes (Heude).

Two specimens, adult females, from Washan in western Szechwan, agree in having no white on the knee or fetlock, but instead these portions are light buff and the anterior side of the fore leg below the knee (metacarpals) is blackish, with a slight admixture of reddish (nearly light "hazel") hairs. The gray rather than white mane is noticeable in both specimens. These characters are pointed out by Pocock (1908, p. 185) in his review of the Serows, as characterizing this race, of which he also mentions two specimens in the British Museum one from Szechwan, obtained from Berezowski in 1896, the other a mounted specimen said to have come from "Tibet" which has been made the subject of a communication by Lydekker (1905, p. 329, pl. 8). In a further communication Lydekker (1908b) maintains the specific rank of this Serow.

The two specimens shot by Mr. Zappey were measured by him as follows: —

Orig. No.	*Length.*	*Tail.*	*Hind Foot.*	*Height at Shoulder.*
175	1590	115	380	860
176	1675	120	388	900

The iris is described as hazel. The first animal is much the younger with horns 125 mm. long; the second has considerably longer horns, measuring 215 mm. in

length, in a straight line from base to tip. They are slightly curved backward and divergent.

A single skull obtained from the natives in the Province, probably also represents this subspecies, as it agrees with the two other skulls in the great breadth, 46 mm., of the combined nasals (these are 48.5 and 42 mm. respectively in the two other skulls). By some accident the left horn core of this skull had been broken off, but was completely covered by horn, smoothly worn.

In addition to the skins and skulls, Mr. Zappey brought back a half dozen pairs of horns, still attached to the occipital portion of their respective skulls. These are without data and hence are not subspecifically identifiable. The largest pair measures from the base at the outer side to the tip in a straight line, 257 mm. This pair is further remarkable in that the horns instead of diverging evenly from the base, after bowing out slightly for the first three quarters of their length are approximated toward their tips so that the latter are scarcely 33 mm. apart.

Capricornis sumatrensis milne edwardsi (David).

A skin with skull, taken at Tachienlu, western Szechwan, at an altitude of 10,000 feet, seems undoubtedly to represent this eastern Tibetan Serow, which here must be nearly at the eastward limit of its range. The coloration of the fore legs, which is considered of diagnostic value in separating the various races of Serows, is nearly uniform cinnamon rufous with some admixture of buffy hairs, but no suggestion of the dark blackish metacarpal patches of the race *argyrochaetes*. The mane is also rather more conspicuously whitish. In the skull, which is that of an adult male, the greatest combined breadth of the nasals is markedly less (33 mm.) than in the skulls of the latter, and the entire nasal region is more arched and laterally compressed.

I have followed Pocock and Lydekker in considering this Serow as a race of the type species from Sumatra. It seems probable, however, that it might with equal propriety be considered a distinct species as their ranges have not been shown to be strictly continuous.

CERVIDAE.

Elaphodus cephalophus Milne Edwards.

An adult female, from Putze, Hupeh, agrees in cranial proportions with those given by Milne Edwards for his specimens from Moupin. The collector's

measurements in the flesh, are:— total length, 1700 mm.; tail, 70 mm.; hind foot, 440 mm.; height at shoulder, about 720 mm.

The skull, compared with that of topotypes of *E. michianus* from Ningpo, in the collection of the Museum, shows strikingly larger proportions than the small coastal form, and as pointed out by Lydekker, the two animals are probably distinct species. The latter author has recently (1904) described as new the tufted deer of Ichang (*Elaphodus ichangensis*) on the basis of two skins and skulls from that vicinity. But one of these is adult and though the differences between the supposed new form and *michianus* are apparent enough, the only character separating *ichangensis* from *cephalophus* is the supposed greater size of the latter. Lydekker gives the "basicranial length" of the male Ichang deer as $6\frac{3}{8}$ inches, against $7\frac{1}{4}$ inches for the corresponding measurements of a female *cephalophus*. This dimension in our adult female, from the same province as *ichangensis* is about $7\frac{1}{8}$ inches. For the present, therefore, it seems preferable to consider our specimen as representing *cephalophus*.

Muntiacus lacrymans (Milne Edwards).

Hilzheimer (1906), has described a new Muntjac under the name of *Cervulus sinensis*, basing his diagnosis on a single skin and skull from Kiukiang on the middle Yangtze. The characters given are of a comparative nature and somewhat intangible, but the author considers his new species to be intermediate between the coastal *reevesi* and the upland *lacrymans* described from Moupin. Mr. Zappey obtained a series of seven skins and skulls from Ichanghsien and Changyanghsien, Hupeh, which should therefore probably represent *sinensis*. I am unable, however, to find any characters, that might not be other than individual peculiarities, to distinguish these from *lacrymans* as described by Milne Edwards. The distinctive features of the skull claimed by Hilzheimer do not seem to be constant in the series studied, and until more detailed comparisons can be made with typical specimens it seems better to consider the latter as representing *lacrymans*. A similar conclusion has been reached by Professor Matschie (1908). No doubt the two species *reevesi* and *lacrymans* will be found to intergrade, and thus to constitute geographical races rather than distinct species.

Hydrelaphus inermis (Swinhoe).

A fine series of eighteen water deer was obtained in Hupeh, all at or near Kwangtitze, on the Yangtze River. The type locality of *inermis* is Chinhiang near the mouth of this same river. Hilzheimer (1906), has described as new,

Hydropotes kreyenbergi on the basis of a single male skull, unaccompanied by skin, from Hankow, also on the Yangtze, in east central Hupeh. Our specimens should thus be referable to the latter species if it is really distinct, but this does not seem clear from the material at present available. Hilzheimer bases his distinction on slight cranial differences, which may be more or less individual and which are mainly derived from a comparison of figures. These differences are chiefly:— (1) in *inermis* the rostral portion of the skull in front of the orbit is about thrice the length of the orbit, while in *kreyenbergi* it is but $2\frac{1}{2}$ times this distance; (2) the least breadth of the combined nasals is in *inermis* somewhat more than $\frac{3}{4}$ their greatest combined breadth; whereas in *kreyenbergi* they are so narrow that their least combined breadth is at most equal to one half their greatest combined breadth; (3) in *kreyenbergi* the upper rim of the orbit is so protuberant that in profile view it hides the median roof of the skull at that point, which is not the case in *inermis*.

In the skulls from Hupeh, these characters are not borne out. Thus in a male from Kwangtitze, the nasals are hardly narrowed distally and at the narrowest point their combined breadth is exactly three fourths the total width at the widest point as in *inermis*. The orbit is contained three times and a slight fraction in the length of the preorbital part of the skull, and the upper orbital rim is on a level with the interorbital parietes. The series shows more or less individual variation in all these characters, and the females as a rule have rather narrower nasals and a more compressed rostrum than the males. Unless therefore, other characters can be discovered, the water deer of the upper and the lower Yangtze must be considered identical.

Moschus sifanicus Büchner.

Owing to ceaseless persecution by the Chinese, the Musk deer has been nearly exterminated in the country where Mr. Zappey collected. The musk glands are keenly sought and much esteemed by the Chinese. In the mountains of western Szechwan, at Shuowlow, a single male was shot at an altitude of 14,000 feet. Although others were seen they were so shy that it was impossible to approach within range.

SUIDAE.

Sus moupinensis Milne Edwards.

Near Tachienlu, in western Szechwan, the skull of a wild pig was procured, which undoubtedly represents Milne Edwards's *Sus moupinensis*. The skull is

that of an old female, with the teeth all present, yet greatly worn down. The condylar region has been broken away, but otherwise the specimen is in excellent condition. Apparently no recent comparisons have been made between this species and those close to it geographically, nor am I able to throw further light on its relationships, though allowing for the worn condition of the teeth in the specimen studied, it seems rather close to the Indian *Sus cristatus*. The vertex of the skull, however, is strikingly broader. The following measurements in millimeters are taken from this skull:— greatest width at vertex, 63; greatest postorbital width, 120; greatest zygomatic width, 142; length from median border of vertex to tip of nasals, 306; length of nasals, 174; greatest combined width of nasals, 35; palatal length, 222; upper molar row, 130; lower molar row, 115; length of mandible, 282; last upper molar, 37 × 22; last lower molar, 41.5 × 19.

LEPORIDAE.

Lepus swinhoei filchneri (Matschie).

A series of nine winter and two summer skins with skulls, appears to represent this inland race of the common Chinese hare. All were taken in Hupeh in the region about Ichang, but none was obtained in the more western province of Szechwan. These specimens agree well enough in color with those described by Swinhoe and Matschie, though without topotypes of the Chefoo hare of Swinhoe, no direct comparison can be made. With the latter, indeed, Thomas has suggested that *filchneri* of Matschie is identical, but Dr. J. A. Allen (1909, p. 426) considers that it is probably a valid subspecies and points out that inland animals from southern Shensi have shorter rostra than those from the coast as indicated by Swinhoe's measurements (1870, p. 449). On this account and on the probability that the inland animals would be slightly differentiated from those on the coast 1,200 miles away, Dr. Allen deems it best to regard Matschie's *Lepus filchneri* from southern Shensi as a distinct race, although the original description contains nothing that is particularly diagnostic. Our specimens agree with those from Shensi in the shortness of the measurement from the postorbital notch to the tip of the nasals as compared with that given by Swinhoe for his Chefoo hare.

Thomas has further indicated that Matschie's *Lepus stegmanni* is doubtless synonymous with *L. swinhoei* or the present subspecies, since the speckling of the black upper tail surface with lighter hairs is not a constant character but

occurs occasionally in any series of this species from a given locality. One or two of the specimens studied show this same variation.

Lepus sechuenensis deWinton and Styan.

A single male taken at the Ramala Pass, in western Szechwan represents this species. The peculiar grayish blue of the backs of the ears, and of the rump, thighs, and tail have been noted by the describers as markedly characteristic. The ears are strikingly long and the hind feet are stout and heavy. The only measurement given in the original description of this hare is that of the skull length — 97 mm. The following are the dimensions of the specimen studied:— total length, 533 mm.; tail, 70; hind foot, 120; ear from anterior base in the dried skin, 130. The skull measures:— greatest length, 90.5 mm.; basal length, 73; palatal length, 40; greatest length of nasals, 36; median length of nasals, 28; greatest breadth of nasals, 17; zygomatic breadth, 43; mastoid breadth, 36; greatest breadth outside upper molars, 22.7; length of palatal foramen, 23.5; mandible from condyle to tip of incisors, 72; alveolar length of upper tooth row, 14.7; alveolar length of lower tooth row, 15.

Notwithstanding that the ears are longer and the skull larger than in the preceding species, the audital bullae are notably smaller.

OCHOTONIDAE.

Ochotona hodgsoni (Blyth).

This mouse-hare seems to be somewhat widely distributed in the high mountains of western Hupeh and Szechwan. A series of eleven specimens representing various ages, was collected at the following localities:— Fanghsien, 9,000 feet; Washan, 8,200 to 11,000 feet; Lianghokow, 13,000 feet; Tachiao, 12,000 to 13,000 feet; Shuowlow, 13,000 to 14,000 feet. The series shows more or less variation in color from a general cinnamon to nearly bistre. The under parts vary according to age or season from grayish white to pale buff. The pelage when fully developed is remarkably full and long. Bonhote in his review of the Old World species of this genus, records specimens of *hodgsoni* from eastern Sikkim, "Gannsu in N. Thibet," and from Szechwan, whence also it has been described by Milne Edwards under the name "*tibetanus*." The specimen from western Hupeh probably marks the general eastward bounds of its range.

Ochotona huangensis (Matschie).

Professor Matschie (1908) has named as new a mouse-hare of the *daurica* group from the upper Yangtze, and to this species I have provisionally referred an immature specimen that evidently is of the same group. Its coloration above is a general dark gray, buffy behind the ears and on the neck, with a tuft of buffy hairs at the inner base of the ear. The vibrissae are unusually long, mostly whitish, and the pelage is very fluffy, almost woolly. It was taken at Yachiakun, in western Szechwan, at an altitude of 12,500 feet.

Ochotona erythrotis (Büchner).

Four specimens of this large species were taken at Nachuka, at altitudes between 10,000 and 12,000 feet, and a single one at Ramala Pass, 15,500 feet, all in western Szechwan, on the eastern borders of Tibet. The species is known from Kansu and from the Burchan Budda Mountains of northeastern Tibet, where it was obtained by the Prjewalski Expedition. The present records therefore extend its known range well to the southward. The measurements of the five adults, as taken by the collector, follow:—

No.	*Locality.*	*Total Length.*	*Tail.*	*Hind Foot.*
7587	Ramala Pass	191	7	35
7588	Nachuka	165	6	34
7589	Nachuka	204	7	35
7590	Nachuka	203	7	35
7591	Nachuka	215	6	35

The skull of No. 7591 measures:— greatest length, 48.2 mm.; basal length, 40.5; palatal length, 19; combined incisive and palatal foramina, 14; zygomatic breadth, 24.2; interorbital constriction, 5; mastoid breadth, 21.7; mandible from condyle to tip of incisor, 34.6; upper molar row, 9; lower molar row, 9.

SPALACIDAE.

Rhizomys vestitus Milne Edwards.

Five specimens of this Bamboo rat were obtained at Washan, in western Szechwan, at from 8,000 to 9,000 feet altitude. The species was described by Milne Edwards on the basis of two immature examples sent by Père David from the region of Kokonow, northeastern Tibet, some four hundred miles north of Washan. Our specimens seem to represent the same species, however, though the measurements differ slightly. Milne Edwards intimated that the dimensions

he gave were probably not maximum and this is undoubtedly true. Our smallest specimen is immature, and its skull agrees almost exactly in size and proportions with that figured by the describer. The four others are adult and considerably larger. The collector's measurements of these follow: —

No.	*Total Length.*	*Tail.*	*Hind Foot.*
7560	451	89	60
7561	434	76	58
7562	395	61	57
7563	386	55	52

The skull of No. 7562 measures: — greatest length, 75 mm.; basal length, 72; palatal length, 48.5; zygomatic breadth, 60; mastoid breadth, 36; interorbital constriction, 11; mandible from condyle to tip of incisor, 61.5; alveolar length of upper cheek teeth, 17; alveolar length of lower cheek teeth, 15; upper diastema, 24; lower diastema, 12.5.

Three of the four adults have a midventral white streak on the chest.

MURIDAE.

Myospalax fontanieri (Milne Edwards).

This species was originally described on the basis of a specimen from Pekin, and later Milne Edwards recorded others from Siwan, sixty miles to the northwest. Thomas (1908a, p. 978) has recently recorded the species from the Ordos Desert in the Province of Shensi, and from localities in the Province of Shansi to the eastward. Two specimens were obtained by Mr. Zappey in Hupeh, at Showlungtan and Kongchikow respectively, constituting apparently the most southeasterly localities yet known for the genus. While seemingly representing Milne Edwards's species, it is possible that they may eventually prove to constitute a slightly different race. In cranial characters they agree closely with *M. fontanieri* as figured by Milne Edwards in his "Recherches." They seem to differ, however, in the absence of a white median streak in the forehead, although in both our examples there is more or less white about the muzzle and on the upper and lower lips. This marking was believed by Milne Edwards to be inconstant, but Thomas found some trace of it in all of his eleven specimens from Shensi and Shansi. Moreover the nose pad in our two specimens is produced at its upper median border into a somewhat mitre-shaped lobe instead of being evenly rounded dorsally as figured by Milne Edwards. The exact value of these differences is not clear in the lack of material for comparison. From

M. cansus they differ in smaller size, and from the recently described *M. rufescens* in this and certain cranial characters as noted by Dr. J. A. Allen (1909).

The measurements of the two specimens as taken by the collector are: —

No.	*Sex.*	*Total Length.*	*Tail.*	*Hind Foot.*
7130	♀	193	38	31
7131	♂	190	35	27

The skulls show that the two specimens are nearly comparable in age, yet that of the female is the smaller. Thomas has pointed out the fact that the skulls of *M. cansus* show a sexual differentiation of a similar nature, those of the males being markedly the larger. The dimensions of the two skulls follow, those of the male in each case first: — greatest length, 39, 37; basal length, 33.5, 31; palatal length, 21, 19.5; diastema, 11.3, 11.2; zygomatic breadth, 26.5, 24.4; interorbital constriction, 8, 8; mastoid breadth, 21.8, 18.5; median length of nasals, 14.4, 13.5; mandible from condyle to tip of incisor, 27.2, 25.8; upper molar row, 9.5, 8.4; lower molar row, 10, 9.

Microtus mandarinus (Milne Edwards).

This rare mouse is represented by six skins and skulls, three from Ramala Pass (at 16,000 feet) and three from Shuowlow (13–15,000 feet), in western Szechwan on the border of Tibet. Milne Edwards described this field mouse from Chinese Mongolia where it was obtained by Père David. His figure and description of the exterior (Recherches hist. nat. mammifères, 1868–'74, p. 129, pl. 12, fig. 4) probably refer to a highly colored specimen as none of the five studied is so brightly ochraceous as he indicates, though in other respects the agreement is close enough. In his figures of the teeth on plate 13, the figures 4c and 4d are interchanged, being the lower and upper molar series respectively. All our specimens agree in color, having the dorsal surfaces a finely grizzled mixture of ochraceous and black-tipped hairs, the lower surfaces gray, with plumbeous bases to the hairs. The tail is short and bicolor like the body.

The measurements in the flesh of five specimens are: —

No.	*Length.*	*Tail.*	*Hind Foot.*
7793	120	28	17
7794	123	23	16
7795	119	23	16
7796	125	24	16
7797	134	27	17

The skull of No. 7796 measures: — total length, 23 mm.; basal length, 21; palatal length, 13; zygomatic breadth, 13.6; interorbital constriction, 3.7;

mastoid breadth, 11; mandible from condyle to tip of incisor, 17; upper molar row, 5.4; lower molar row, 5.3.

Mr. Oldfield Thomas (1909, p. 976) has recorded two specimens of this species from the Province of Shansi, twelve miles northwest of Kolanchow at an altitude of 7,000 feet.

Microtus chinensis Thomas.

The type of this vole was taken from the stomach of a snake at Kiatingfu in western Szechwan. At Washan, western Szechwan, Mr. Zappey obtained a series of twenty-one skins at altitudes of from 6,000 to 10,000 feet and Thomas (1911, p. 175) has recorded specimens from Omeihsien and 23 miles south of Tachienlu. The remarkable development of the third upper molar, the comparatively long tail, the presence of six pads on the sole of the hind foot, and the possession of four mammae are peculiarities already pointed out by Thomas and used by Miller as the basis of the separation of this species as the type of the subgenus, Anteliomys.

Microtus (Eothenomys) melanogaster (Milne Edwards).

Apparently this is a commonly distributed species in the highlands of southwestern China. Mr. Zappey obtained specimens from Hsientientze and Changyanghsien, Hupeh, and from Washan in western Szechwan, at altitudes of from 4,150 feet at the second locality to 8,000 feet at the last named. Thomas has also recorded it from northwestern Fukien. One specimen of our series is partially albinistic with a white median ventral line from the chin to a point between the fore legs where it joins a small white patch some 14 mm. in transverse diameter.

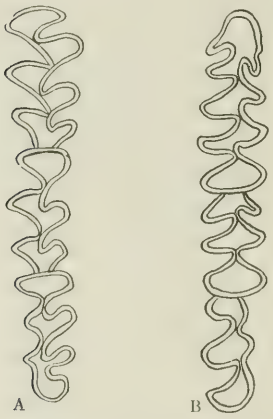
The measurements of an adult, No. 7800, taken in the flesh by the collector, are:— total length, 129 mm.; tail, 39; hind foot, 16. The skull of No. 7802 measures:— greatest length, 23.4; basal length, 21.5; palatal length, 12.2; zygomatic breadth, 13; mastoid breadth, 11; interorbital constriction, 4; mandible from condyle to tip of incisor, 16.2; greatest depth of mandible from coronoid process, 7.6; upper cheek teeth, alveoli, 6; lower cheek teeth, alveoli, 6.1.

Microtus (Eothenomys) aurora, sp. nov.

Type:— Skin and skull No. 7788 M. C. Z., male, from Changyanghsien, Hupeh, China. February 2, 1909, Walter R. Zappey.

General Characters:— Larger than *M.* (*Eothenomys*) *melanogaster*, pelage long and soft, ears rather small. Color reddish brown above, and dark slate washed with brownish below. Skull large, with rather prominent postorbital shelf-like ridges; teeth essentially as in *M. melanogaster*, but the third upper molar longer and with a long, narrow external heel.

Color:— Dorsal surface of body, forehead, and cheeks, nearly "tawny" of Ridgway, with peculiar bright yellow brassy reflections. The individual hairs are about 11 mm. long, dark slate-black except at the tips which are tawny to tawny-ochraceous; mixed with these hairs are others of the same fine texture but slaty black throughout, so that a general tawny appearance is produced in which the black is less conspicuous than in those species that have the black hairs longer than the general body hairs. The muzzle is a grizzled gray without tawny. Sides of the body hardly lighter than the back, the color grading insensibly into that of the ventral surface which is gray washed conspicuously, except on the thighs and throat, with ochraceous buff. The slaty bases of the hairs show through everywhere so as to darken the grayish of the belly but not to such an extent as to produce the blackish seen in the ventral surfaces of *M. melanogaster*.



Microtus (*Eothenomys*) *aurora*. Type No. 7788. A, Enamel pattern of right upper molars; B, Enamel pattern of right lower molars.

Tail covered with short blackish hairs above, which become slightly grayish below, so that the tail is indistinctly bicolor. Feet with short brown hairs, nearly Prout's brown, with grayish reflections. The short round ears are thinly covered with minute hairs of a similar color.

Skull:— Compared with that of *M. melanogaster*, the skull is larger and heavier, with more prominent ridges and angles. The postorbital processes protrude as narrow shelf-like ridges, and the zygomata are stouter and more bowed. The palate is marked by two shallow longitudinal grooves that end posteriorly each in a deep pit or perforation of the palate. The hinder margin in the type is practically straight across, though in another specimen it is slightly protuberant medially, yet not forming a spinous process.

The enamel pattern of the first upper molar (Figs. A, B) consists of four closed triangles, succeeded by a fifth space in which the two folds of opposite

sides are confluent medially. There are three salient angles externally and four internally. The second upper molar is essentially similar but with one less triangle, so that there are three salient angles on each side and the enamel folds of opposite sides are partly open at their bases. The third upper molar has the usual anterior tranverse prism succeeded by two nearly opposite folds, then a trefoil of three lobes, two internal, one antero-external, so that the tooth has three external and four internal salient angles or slightly rounded lobes.

The anterior lower molar consists of an anterior closed enamel space having one external and two internal projections, followed by three transverse spaces formed by the confluence medially of the enamel folds of opposite sides. This tooth has therefore four external and five internal salient angles. The second lower molar is of the usual three transverse prisms formed by the confluence of the enamel folds of opposite sides. The third lower molar is similar but the external reentrants are shallow notches while those of the internal side are deep and run forward at a strong angle to the longitudinal axis. Each of these two last teeth has thus three external and three internal angles.

Measurements:— The measurements of the type and three other specimens, taken in the flesh by the collector, follow:—

No.	*Total Length.*	*Tail.*	*Hind Foot.*
7788 *Type.*	148	43	18.5
7185	145	41	15
7186	147	48	17
7188	139	40	16

The skull of the type presents the following dimensions:— greatest length, 25.8; basal length, 23.3; palatal length, 13; zygomatic breadth, 14.3; interorbital constriction, 4.4; mastoid breadth, 11.8; upper diastema, 6.7; mandible from condyle to tip of incisor, 17; alveoli of upper molars, 6; alveoli of lower molars, 5.8.

Remarks:— Four specimens of this interesting species were secured by Mr. Zappey, in Hupeh, three at Changyanghsien and one at Kwangpow. It is a very rusty-looking animal approaching a dark Evotomys in color above, due in part to the suppression of black hairs, while the tawny wash on the belly is remarkably unlike the color of *M. melanogaster* or the next species about to be described. In these respects it probably approaches *M.* (*Caryomys*) *inez*, recently described by Mr. Oldfield Thomas (1909, p. 976) from the mountains of Shansi and differs equally from his newly described *M. melanogaster eleusis* from northern Yünnan which it approaches in size. It is noteworthy that Mr.

Zappey did not find any representative of the subgenus Caryomys (Thomas, 1911, p. 175), four species of which are now known, *alcinous*, *inez*, *nux*, and *eva*.

Microtus (Eothenomys) mucronatus, sp. nov.

Type:— Skin and skull No. 7789 M. C. Z., female adult, from Tachiao, western Szechwan, at an altitude of 12,000 feet. August 11, 1908, Walter R. Zappey.

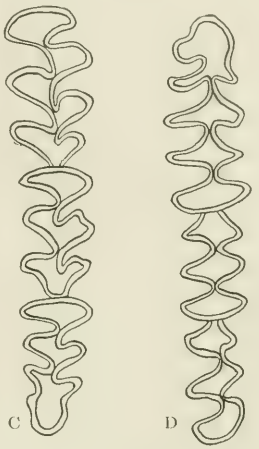
General Characters:— A large Eothenomys, with larger ear and hind foot, browner color, longer and fuller pelage than *M. melanogaster*. Skull larger than that of *M. aurora* with distinctly bowed zygomata, broader muzzle, and with deeper palatal grooves and a prominent median spine at the posterior edge of the bony palate. Third upper molar with but six prominent angles and its posterior heel nearly bilaterally symmetrical.

Color: — Entire upper surface of the body a fine grizzle of blackish hairs and hairs with cinnamon-rufous tips, producing a general "mummy brown" tone. The bases of the hairs are dark slaty black, with the cinnamon-rufous confined to a space of a millimeter or two at the tip. Under a lens, many of these rusty-tipped hairs are seen to have a very fine darker point. The lower surfaces, including the upper lips and base of the nose are dark slate color with a very slight buffy wash between the fore legs. Feet and tail covered with short hair-brown hairs, those of the latter slightly paler ventrally.

Skull: — In general appearance the skull is like that of a large *M. melanogaster* but the zygomata are more bowed. The palatal region shows several striking peculiarities. The palatal grooves, which in *melanogaster* are so shallow as to be scarcely appreciable, in *mucronatus* are deep and conspicuous, running one from each of the incisive foramina to near the posterior edge of the palate, where in both species they end in two pit-like perforations. The bony palate instead of ending in an evenly truncated shelf, has a prominent median spine as in *M. chinensis* of the related subgenus Anteliomys. The lower jaw is very massive and strikingly broad in side view as compared with *M. aurora* and *M. melanogaster*.

The teeth are essentially as in the latter species, but much heavier throughout (Figs. C, D). The first upper molar shows the usual large anterior transverse prism succeeded by three *closed* triangles and a posterior enamel space which is formed by the confluence of two small folds of opposite sides, the outer of which is slightly in advance of the inner. There are thus three external and four

internal salient angles. The second upper molar consists of three closed transverse prisms, the outer angles of which are slightly in advance of the corresponding angles of the inner side. The tooth has three salient angles on each side. The last upper molar is much like the one preceding, but the posterior enamel space, which has two small and opposite prisms at its anterior end, is produced in the long axis of the tooth into a narrow heel, with nearly parallel sides. There are therefore six salient angles in this tooth as in the second molar. In the specimen figured, however, there are indications of a small additional pair of angles, one on the outer and one on the inner side of the posterior heel, and this condition I also found in a specimen of *M. melanogaster*.



Microtus (*Eothenomys*) *mucronatus*. Type No. 7790. C, Enamel pattern of right upper molars. D, Enamel pattern of right lower molars.

The first lower molar has four closed enamel spaces the anteriormost with two internal and one external prominent projections; the three other spaces, are formed by the confluence of the prisms of opposite sides into a single transverse space. The tooth has four external and five or even six internal salient angles according as the very small antero-internal point is less or more developed. The second and third lower molars show each three transverse closed spaces, and each has three salient angles on either face. The reentrants of the third lower molar are somewhat deeper externally than in *M. aurora*.

Measurements: — The type and three other specimens were measured in the flesh by the collector, as follows: —

No.	*Total Length.*	*Tail.*	*Hind Foot.*	*Sex.*
7789 *Type.*	144	39	19	♀ ad.
7790	162	44	19	♀
7791	105[1]	45	19	♀
7803	130	37	19	♀ imm.

The ears of the dried skins measure 11 or 12 mm. in length from the meatus, which is 3 or 4 mm. greater than the corresponding dimension in skins of *M. melanogaster*.

The skull of the type measures: — greatest length, 26; basal length, 23.8;

[1] Probably a mistake since the skin as made up is quite as large as the other specimens and measures 137 mm. in length.

palatal length, 14.3; zygomatic breadth, 15.5; mastoid breadth, 12; interorbital constriction, 4.6; mandible from condyle to tip of incisor, 18.4; greatest vertical height of mandible at tip of coronoid process, 9; alveoli of upper molar row, 6.7; alveoli of lower tooth row, 6.8.

Remarks: — The relationship of this species is undoubtedly with *M. melanogaster*. The enamel pattern of the molars is essentially similar and the coloration not so brown as is that of *M. aurora*. The presence of a distinct median spine at the posterior edge of the palate is apparently unusual in the subgenus and recalls the condition in the subgenus Anteliomys, between which and Eothenomys the new species may be somewhat annectent.

The fur of *M. melanogaster* is close and short, recalling that of the subgenus Pitymys, and this in connection with the small ear may indicate that the species is more subterranean in its habits than *M. aurora* or *M. mucronatus* in both of which the fur is long and soft and the ear larger. From the former, *M. mucronatus* is at once distinguished by its blacker coloration, quite without the rusty tinge above and the brassy reflections, while the belly is blacker much as in *melanogaster*. The slight but constant differences in the shape of the enamel folds of the molars, as well as the more massive skull with the deep palatal grooves and prominent median spine are further striking differences.

In addition to the type, Mr. Zappey obtained three other specimens, all at Tachiao, western Szechwan, where however, he did not find any other species of the subgenus. Milne Edwards in his original description of *melanogaster* remarks on what he calls a brown phase of that species, occurring in the same localities and it is not impossible that these brown animals are really the new species here described. The skull, figured of natural size, seems to be a trifle larger than that of our specimens of *melanogaster*, but the details of structure as well as the description and measurements given in the text refer clearly to the small black species.

The two species of the subgenus Eothenomys here described do not seem referable to any of the half dozen forms lately described by Mr. Thomas from western and southern China.

Craseomys aquilus, sp. nov.

Type: — Skin and skull No. 7190 M. C. Z., male adult, from Showlungtan, Hupeh, China. May 17, 1907, Walter R. Zappey.

General Characters: — A very brown species, appearing superficially much like a brown Microtus; tail long, more than half the length of head and body.

Skull with well-developed ridges, zygomata slightly bowed, palate normal with a slight median convexity at the posterior edge. Last upper molar with six salient angles, the posterior enamel space somewhat Y-shaped.

Color: — Dorsal surface of the head and back a general dark rusty, between russet and cinnamon of Ridgway. This is produced by a mixture of entirely blackish hairs with others whose bases are slaty black with narrow tips of bright tawny approaching orange-rufous. Under a lens, many of these latter hairs are seen to have a minute dark tip. Towards the sides of the head and body the bright-tipped hairs predominate producing a nearly clear tawny ochraceous. A small dark patch in front of each thigh, about 10 mm. in vertical height by 5 mm. in length is of a slate-gray. Ears prominent and thinly clothed with short hairs nearly Prout's brown in color.

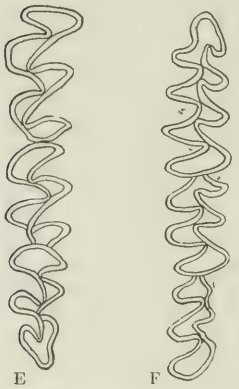
Lips, ventral surface of the throat and limbs nearly gray No. 6 of Ridgway, becoming whiter on the ventral surface of the body on account of the whitish tips to the hairs which conceal the slaty bases. Upper surfaces of the feet covered with short pale gray hairs. Tail bicolor, Prout's brown above, grayish below, with a distinct pencil about 4 mm. long.

Five other specimens agree with the type in color except that one or two have a faint buffy tinge to the gray hairs of the belly. All five are females and do not show the spot on the hip that covers the lateral gland in the male.

Skull:— The skull has the general appearance of that of an Evotomys, short and rather delicate but the postorbital ridges of the squamosal are more prominent, the zygomata are slightly expanded, and the second upper and third lower molar are distinctly encapsuled. The palate is normal but instead of ending in a straight-edged shelf posteriorly, has a slight median convexity. The palatal grooves are distinct but shallow from each of the incisive foramina, and end in the usual perforation close to the posterior palatal margin. In all the skulls this perforation is completely bridged by the bony palate. The pterygoids are nearly parallel distally and their hamular processes abut each against the antero-internal end of the audital bulla. The diastema is practically as long as the alveolar length of the molar row.

The teeth (Figs. E, F) show less complexity in the enamel pattern than those of the Evotomys available for comparison, and there seems less tendency for the triangles to be open. The first upper molar has the usual five spaces, all closed, and three salient angles on each side, the internal more rounded than the external. The second upper molar has four closed spaces as usual with three external and two internal angles. The third upper molar resembles that of *Evotomys* (*"Phaulomys"*) *smithi* in its simplicity and approach to bilateral

symmetry. It consists of an anterior transverse enamel space, succeeded by two small closed triangles, the outer slightly in advance of the inner and more sharply angular. Then follows a terminal Y-shaped space whose outer anterior lobe is slightly the longer. The tooth has thus three external and three internal salient angles. No variation from the condition here described is shown by any of the six specimens.



Craseomys aquilus. Type No. 7189. E, Enamel pattern of left upper molars. F, Enamel pattern of right lower molars.

In the first lower molar of the type there are four salient angles on either side. The posterior enamel space is the usual transverse crescent, anterior to which are two inner and two outer alternating closed triangles. The anteriormost closed space has a small angle on either side at its posterior end. The second lower molar has but two closed triangles and at each end of the tooth a transverse closed space, the anterior of which is deeply cut by the first outer reentrant. The third lower molar has the usual three transverse loops, the anteriormost smallest and almost oval in outline. Like the preceding tooth, it has three external and three internal salient angles, but the outer reentrants are very much shallower than the inner.

In Nos. 7189 and 7192, the antero-internal notch of the first enamel loop of the first lower molar is so well developed that it nearly cuts off a fifth triangle while in No. 7191 this reentrant is still deeper and completely cuts off this triangle so as to produce two external and three internal closed triangles in addition to the anterior loop and the posterior transverse crescent. In this specimen, therefore, there are four external and five internal salient angles. In No. 7194 this tooth is as in the type.

Measurements:— The following measurements were taken in the flesh by the collector:—

No.	*Total Length.*	*Tail.*	*Hind Foot.*
7189	152	57	17
7190 *Type*	160	59	20
7191	144	55	18
7192	157	55	19
7194	150	54	17
7196	145	52	19
Average	151	55	18

The skull of the type measures:— greatest length, 23.8; basal length, 22; palatal length, 12.3; upper diastema, 6.6; zygomatic breadth, 13.5; mastoid breadth, 11.6; interorbital constriction, 3.5; mandible from condyle to tip of incisor, 16.5; alveoli of upper molar row, 6; alveoli of lower molar row, 5.

Remarks:— The type, as stated, came from Showlungtan, Hupeh. The five other specimens are from the same Province: two from Fanghsien at altitudes respectively of 7,600 and 9,000 feet; one from Wansonshan at 7,225 feet, and the two others from the type locality, altitude not noted. It is doubtless a boreal representative found at the higher altitudes, and is the most southern species of its genus hitherto discovered in China. In its brown Microtus-like coloration and its molar pattern with the simple structure and approach to bilateral symmetry of the upper third molar, it seems to approach *Evotomys* (*Phaulomys*) *smithi* of Thomas, from Hondo, Japan. It is quite unlike the other described species of Craseomys from southeastern Asia — the large-bodied, richly colored *C. regulus* of Korea and North China, and the large pale *C. shanscius* from the Province of Shansi.

According to Anderson (1909) who has recently compared a large series of *Evotomys smithi* there is much doubt if the subgenus Phaulomys, based on that species, is really distinguishable.

Apodemus agrarius ningpoensis (Swinhoe).

Thomas has recently shown that Apodemus antedates Micromys for the small Mus-like species having three inner tubercles on the first and second upper molars, and in his summary of the described forms of the *agrarius* group (Thomas, 1908b, p. 8) differentiates *A. a. pallidior* of the Shantung peninsula as a grayer race than the more southern *A. a. ningpoensis*, in which, moreover, the dorsal streak is usually obsolete. Mr. Zappey obtained a fine series of thirty skins and skulls from Ichang and vicinity. These skins, although showing great individual variation are probably best referred to *ningpoensis*, the type of which came from Ningpo, on the coast, some six hundred miles to the west. All were taken in December and January, 1908. In three the black dorsal line is splendidly marked from a point between the ears to the root of the tail, broad, clear, and conspicuous. Three others have it nearly as well marked, but it begins on the nape or between the shoulders. In four other skins, the stripe is still well defined, but no longer clear black on account of a slight admixture of the buffy hairs of the rest of the back. In the remaining twenty specimens the stripe

is more or less obsolete; in six or seven it is scarcely noticeable except as a slightly darker median band. There is said to be no trace of a dorsal stripe in the type specimen of this race. In size and cranial measurements our specimens seem to agree with the dimensions given by Bonhote (1905, p. 397). Mr. Zappey did not obtain this species higher up the valley so that it may be of lowland distribution. Bonhote, however, records *A. a. manchuricus* from southern Shensi.

Apodemus minutus pygmaeus (Milne Edwards).

A young, though nearly full-grown specimen was taken at Changyanghsien, Hupeh, November 16, 1907, but elsewhere the species was not met with. It was originally described from Szechwan by Milne Edwards, and Bonhote (1905) records specimens in the British Museum from Kuatun and Shanghai.

Apodemus sylvaticus draco (Barrett-Hamilton).

A series of twenty-five specimens of the long-tailed field mouse seems, after careful comparison, to represent but this single race, although they come from widely separated localities, namely: – Changyanghsien 8,000 feet, Fanghsien, 8,500 feet, and Showlungtan, Hupeh; Mohsimien 8,000 feet, Washan, 6,000 to 9,000 feet, Lianghokow, 12,000 feet, and Tachiao, 12,000 to 13,000 feet, in Szechwan. About one third of the specimens have acquired the mature coloration, a bright russet or ochraceous buff above and on the sides, with a dorsal black area while the remainder exhibit various darker shades in which black hairs predominate on the back and are mixed on the sides to a less extent. The tails of these darker individuals are much less markedly bicolor than those of the russet-colored adults. One of the latter from Washan is almost clear orange-ochraceous, on the nape, shoulders, and sides, with but a slight admixture of black hairs on the lower back. The collector's measurements for seven adults average:— total length, 184 mm., tail, 95, hind foot, 23. Bonhote (1905) gives 186, 95, and 20 respectively. The skull of No. 7139, from Fanghsien measures:— greatest length, 26.8; basal length, 21; palatal length, 12; upper diastema, 7; incisive foramina, 4.5; nasals, 10.8; breadth of brain case, 12; upper molars, 4.4. These dimensions agree very closely with those given by Bonhote for specimens from Kuatun, northwest Fukien.

Apodemus major (Radde).

In the high mountains of western Szechwan near the eastern borders of Tibet occurs a large field mouse evidently related to *A. sylvaticus*, that I have

referred to Radde's "*Mus sylvaticus* var. *major*" (Reis. Sib., 1862, 1, p. 180). In his review of this group, Barrett-Hamilton (1900, p. 412) states that he has seen no specimens but considers it as probably "the western Siberian representative of *M. s. princeps*" of southeastern Europe. He also believes that the specimens obtained by Przewalski in the mountains of Kansu, and described by Buechner as *Mus chevrieri*, are the same animal. In the absence of material for direct comparison, our series agrees well enough with the description to make this conclusion seem probable. Sixteen skins with skulls were collected by Mr. Zappey at Lianghokow, 12,000 feet; Tachiao, 12,000 to 13,000 feet; Shuowlow, 13,000 to 15,000 feet; and Ramala Pass, 15,000 feet. Possibly these localities indicate approximately the southeastern border of this mouse's range which may thus extend north through Kansu to Siberia. The fact that at Tachiao it occurs together with undoubted examples of the smaller *A. sylvaticus draco* seems to indicate its specific distinctness from the latter. The coloration is decidedly paler than in the latter, between buff and ochraceous buff above finely lined throughout with black, especially on the mid-dorsal area; the tail is sharply bicolor even in the immature examples; the feet are white, and the under parts whitish, with the slaty bases of the hairs slightly showing through. The ears are conspicuously large, measuring in the dried skins from 18 to 20 mm., as against 15 and 16 for *A. s. draco*.

The following measurements were made by the collector in the field: —

No.	*Locality.*	*Total Length.*	*Tail.*	*Hind Foot.*
7641	Lianghokow	230	113	27
7642	Shuowlow	221	117	25
7644	Shuowlow	220	110	27
7643	Shuowlow	231	112	26
7646	Tachiao	214	113	27
7648	Tachiao	211	109	26
	Average (6)	221	112	26

Radde gives total length 215; tail, by calculation, 97; hind foot 24.

The skull is large, the teeth broad and heavy. The interorbital constriction is so great that the external faces of the molars can be seen when the skull is viewed from above. The supraorbital ridge extends backward to a point about opposite the posterior root of the zygomatic arch. The notch formed by the upper edge of the antorbital foramen is very much deeper in the long axis of the skull than in the skull of *A. s. draco*. The following cranial measurements are taken from No. 7644: — total length, 29.9; basal length, 23; palatal length, 14.6; nasals, 12; incisive foramina, 6; upper diastema, 7.2; zygomatic breadth,

14; interorbital constriction, 4.4; mastoid breadth, 12; greatest width outside last upper molar, 6; length of mandible from condyle to tip of incisor, 19; upper molar row, 5.3; lower molar row, 5.

An adult female has eight mammae, four pectoral, four inguinal.

Since the above was written, Mr. Thomas has described as *Apodemus speciosus latronum* a field mouse from Tatsienlu which seems to be the same as that here referred to *A. major*.

Apodemus chevrieri (Milne Edwards).

Originally described from the 'principality of Moupin,' this mouse has remained rare in collections, if not practically unknown. At Washan, in western Szechwan, Mr. Zappey obtained a series of thirteen specimens, at altitudes of between 6,000 and 8,000 feet; and at Hsienshanhsien, Hupeh, a single male at 4500 feet, which though a trifle grayer than the Washan series is probably identical. Barrett-Hamilton (1905) has considered this form as probably a race of *Apodemus sylvaticus*, but it undoubtedly is a distinct species. Moreover, it occurs in the same districts with *A. s. draco*. More recently Thomas (1911, p. 172) made it a race of *A. speciosus*, but in a later paper (1912) received as this goes to press, recognizes its specific rank. Milne Edwards's figure of '*Mus chevrieri*' is very nearly matched by an adult female in our series, the brightest of the specimens obtained. In general appearance, the majority are rather paler ochraceous buff, everywhere on the back and sides lined with coarse black hairs which are so evenly distributed over the entire upper surfaces of the head and body as to produce an unusually uniform and equal admixture, scarcely darker even in the mid-dorsal region. The lower surfaces of the body are gray, slightly darkened by the dull slaty bases of the hairs showing through. The tail is bicolor, without sharp line of demarcation, and the feet are whitish. The long hair of the back tends to be hispid, which gives a much coarser appearance to the pelage as compared with the full soft fur of *A. s. draco* for example. In one old female, No. 7657, the hair is practically spiny. As shown in Milne Edwards's figure (Recherches, pl. 40, fig. 2) the ear is short, its base partly concealed in the fur, markedly smaller than in the specimens of the *sylvaticus* group available for comparison (13 mm. in dried specimens). This fact as well as the shortness of the hind foot are remarked by Milne Edwards. Barrett-Hamilton states that Mr. Oldfield Thomas has examined the typical series in the museum at Paris, and has noted the spiny character of the pelage in certain of the specimens.

One measured by Mr. Thomas was 190 mm. in total length; tail, 90; hind foot, 21.5. The following measurements were made in the field by Mr. Zappey: —

No.	*Total Length.*	*Tail.*	*Hind Foot.*
7622	180	84	24
7623	181	84	23
7625	183	85	24
7630	203	95	23
7631	204	106	22
7657	198	99	22
7658	199	102	24
Average (7)	192.5	93	23

The skull, compared with that of *A. s. draco*, is scarcely longer notwithstanding that *chevrieri* is a larger animal. This is due to the relative shortness of the rostrum, which in *draco* is more elongated and slender. The supraorbital crests are strongly developed and extend backward to a point opposite the posterior zygomatic root. The teeth are conspicuously heavier, the palate wider and the audital bullae larger than in *draco*. Following are the measurements of the skull of No. 7657, from Washan:— greatest length, 28.3; basal length, 24.8; palatal length, 14.6; incisive foramina, 6; upper diastema, 8; nasals, 11; zygomatic breadth, 13; mastoid breadth, 11.7; interorbital constriction, 4.4; greatest breadth outside third upper molar, 5; length of mandible from condyle to tip of incisor, 18.4; upper molar row, 5; lower molar row, 4.6.

There are four pectoral and four inguinal mammae.

Mus musculus Linné.

But a single specimen of the House mouse was obtained by Mr. Zappey, this a female at Ichang, Hupeh. Bonhote (1905, p. 394) notes that this mouse does not seem to be common in China though the British Museum has specimens from widely separated localities in that country.

Epimys confucianus (Milne Edwards).

Milne Edwards described this species from specimens collected by Père David in the mountains of Moupin and the Province of Szechwan. Mr. Zappey obtained one at Kiating, in western Szechwan, which may therefore be considered practically a topotype. It is nearly identical with three other specimens

obtained in Hupeh, at Ichang, Ichanghsien, and Changyanghsien, respectively. Two of these taken in January seem to have completely assumed the winter pelage which is soft and full. The other two, mid-November skins, are in process of moult and retain numerous stiff spiny hairs in the dorsal areas. Although the series is too small to warrant definite conclusions, it is possible that the stiff hairs are more characteristic of the summer pelage, as in some species of Apodemus. According to Thomas (1908b, p. 6) however, "the members of this group are not known to change seasonally in this respect." In all four the tip of the tail above as well as below is white for about the distal third.

Bonhote in his review of Chinese species of Mus (Epimys), gives the following dimensions:— head and body 164, tail 192, hind foot 39. These measurements seem very large, since Milne Edwards in his original description gives 170, 165, and 30 mm. for the corresponding dimensions. Thomas, for the Chefoo race, *E. c. sacer*, which he says is of about the same size, gives for extremes:— head and body, 130–156; tail, 170–186; hind foot, 28–31. Bonhote's measurement of the hind foot, 39 mm., must be a misprint, although used as a differential character in his key.

Our specimen from Kiating, Szechwan, was measured by the collector as follows: — head and body, 149; tail, 177; hind foot, 28–32.

Epimys jerdoni Blyth.

This is a hill species, originally described from Sikkim. Its distribution is stated by Blanford (Mamm. Brit. India, 1888, p. 412) to be the eastern Himalayas. At Ramala Pass on the eastern border of Tibet, and at an altitude of 12,500 feet, Mr. Zappey obtained two specimens that seem undoubtedly to represent this species, here probably nearly at the northeastern limit of its range. Farther east its place seems to be taken by the closely allied *E. confucianus*. The first of these specimens was captured August 11, 1908, and is in good summer pelage. The somewhat brighter ochraceous tint of the dorsal surface is noticeably in contrast with that of specimens of *E. confucianus*, and the abundance of whitish spines gives a slightly grayish cast to those parts where their bases show through. The upper surface of the fore feet is clear white without the dark median area of *confucianus*, and the tail is without a white tip. The second specimen is slightly smaller but apparently of the same species. The collector's measurements of these two are:— total length, 365, 360; tail, 192, 163; hind foot, 34, 30.

EPIMYS ZAPPEYI, sp. nov.

Type:— Skin and skull No. 7607 M. C. Z., male adult, from Washan Mountains, western Szechwan, China, at an altitude of 9,000 feet. October 26, 1908, Walter R. Zappey.

General Characters:— Resembling *E. confucianus*, but with darker face, ears, and back, the ochraceous of the sides much richer and brighter, encroaching more on the belly and extending on to the thighs and on the lower throat to the axilla. Ventral surface pure white, without the faint sulphury suffusion. Skull slightly smaller than that of *E. confucianus* with more slender rostrum and zygomata, longer and narrower incisive foramina, narrower palate, and smaller, more flattened bullae.

Color:— Muzzle and an ill-defined patch extending from the base of the vibrissae to the ear, slate color; forehead and crown, nape, and a somewhat oval mid-dorsal area a mixture of hairs mainly slate minutely tipped with ochraceous buff, and longer hairs entirely black. The ochraceous buff tips in this area are so restricted that the dark color predominates forming a darker and more pronounced mid-dorsal area than in *M. confucianus*. Cheeks, sides of the neck, upper surfaces of forearms, the flanks, inner sides of the thighs and lower legs, and the anal region bright tawny ochraceous, only very slightly mixed with scattering short black hairs. A small spot of the same color on the upper chest medially between the fore legs. The color of the back and sides encroaches farther on the belly than in *M. confucianus* and is sharply marked off from that of the lower surfaces, which including the upper lips, chin, and throat, are clear snowy white to the bases of the hairs, quite without the wash of sulphury found in *E. confucianus*. Upper surface of fore and hind feet clove-brown medially, the toes and borders white. Tail white ventrally and for the terminal third dorsally, the proximal two thirds nearly clove-brown above, covered with minute setae that become short hairs distally till they form finally a distinct pencil about 6 mm. long.

Skull:— The skull of the type is evidently adult but not old; the teeth are somewhat worn but the supraorbital ridges are not very strongly developed. Compared with that of *E. confucianus* the rostrum and the zygomata are much slenderer, the nasals narrower and more compressed laterally at their free end. The incisive foramina are longer and narrower, not short and broadly expanded; the palate is narrower and the anterior end of the interpterygoid fossa scarcely expanded. The audital bullae are conspicuously smaller and flatter.

Measurements:— The external measurements of the fresh specimen are recorded by the collector as follows:— total length, 310; tail, 184; hind foot, 31. The size is thus practically as in *E. confucianus*. The measurements of the skull follow, and for comparison the corresponding dimensions of *E. confucianus* from No. 7605, from Kiating, western Szechwan are added in parentheses:— greatest length, 35.5, (37); basal length, 29.7 (30.3); palatal length, 17 (17); incisive foramina, 6.5 × 1.8 (5.4 × 2.8); nasals, 13 (15); zygomatic breadth, 16 (17.6); mastoid breadth, 12.7 (13.2); palatal width outside last upper molar, 6.1 (6.8); mandible from condyle to tip of incisor, 22 (22.5); upper molar row, 6 (6.2); lower molar row, 5.8 (6).

Remarks: — This is a species of the *Epimys niveiventer* group, and as already pointed out, seems nearly related to *E. confucianus*. I should have hesitated to describe the species on the basis of a single specimen were it not for its striking color and cranial characteristics. It is not impossible, also, that as in case of certain other vertebrates, it is a species that has become locally differentiated and is confined to this isolated group of mountains. One of its noticeable peculiarities is the encroachment of the lateral coloration on the venter, producing a narrowed white median area, which is only about two thirds as wide as in similarly prepared skins of *E. confucianus*.

I have named the species in honor of Mr. Walter R. Zappey, to whose zeal and skill is due the discovery of this interesting animal.

Epimys niveiventer (Hodgson).

Four specimens from near the eastern border of Tibet seem to represent this Himalayan species; two are from Ramala Pass at 12,500 feet and two from Nachuka at from 11,000 to 12,000 feet in extreme western Szechwan. Probably as in case of other Himalayan species, these highlands mark the eastern boundary of the range of this rat.

Epimys ling (Bonhote).

This small rat, recently described by Bonhote from Chinfenling, in northwestern Fukien, seems to be a species of the lower elevations of eastern China. At all events Mr. Zappey did not find it west of the Province of Hupeh. In this province, however, he obtained ten specimens at the following localities: — Changyanghsien, Chetzekow, Hsienshanhsien, and Ichanghsien, between altitudes of 4,500 and 5,600 feet. The extremes measured by the collector are: — total length, 250–280; tail, 135–170; hind foot, 26–31.

Epimys flavipectus (Milne Edwards).

Three specimens from Ichang, Hupeh, represent this species, which, though originally described from Moupin, seems to be widely spread in southern China. In but one is the white breast mark apparent, and all are a pale cream-buff below. Two measured by the collector are as follows: — total length, 303, 325; tail, 155, 178; hind foot, 34, 31.

Epimys griseipectus (Milne Edwards).

The collection contains a single adult male that seems undoubtedly referable to this rat, the type locality of which is Szechwan. Our specimen comes from the same province, at Kiating. Bonhote points out that this rat differs strikingly from *E. flavipectus* in its larger size. The bicoloration of the tail is scarcely noticeable in the specimen studied, but the pure white fore feet as stated by Bonhote, seem to be a character constantly distinguishing the species from *flavipectus*, in which the upper sides of the feet are brown edged with whitish. The color of the under parts is also a trifle whiter. The measurements of our specimen, which seems to be of maximum size, are: — total length, 376; tail, 194; hind foot with claws, 41. The skull measures: — greatest length, 47.4; basal length, 41; palatal length, 25; nasals, 18.7; incisive foramina, 8.2; upper diastema, 12.7; interorbital constriction, 6.3; zygomatic breadth, 21; mastoid breadth, 17; mandible from condyle to tip of incisor, 30.5; upper molar row, 8; lower molar row, 7.5.

Epimys norvegicus (Erxleben).

A single adult was taken at Ichanghsien, Hupeh, and two immature examples at Kiating, in western Szechwan. It is interesting to note how distinctly this rat stands out from among the native species by its peculiarly coarse long pelage.

SCIURIDAE.

Marmota himalayanus (Hodgson).

Milne Edwards described this marmot from the mountains of Moupin as a species distinct from *himalayanus* which he knew by descriptions only. He supposed that it differed in color and named it *Arctomys robustus*, but DeWinton and Styan (1899) agree with Blanford in considering it identical with *hima-*

layanus. Mr. Zappey obtained an adult female from Shuowlow, in the western border of Szechwan, at an altitude of 15,500 feet and a smaller specimen from Kaoerhshan, a few days later at a similar elevation. The color is less ochraceous than that represented in Milne Edwards's plate, more nearly a cream-buff. The adult specimen measured by the collector: — total length, 705; tail, 135; hind foot, 88. The skull measures: — greatest length, 103; basal length, 94; palatal length, 57; zygomatic breadth, 64; breadth between tips of postorbital processes, 46; postorbital constriction, 17.3; mastoid breadth, 46; upper diastema, 27; mandible from condyle to tip of incisor, 79; upper molar row, 23; lower molar row, 22.3.

Dremomys pyrrhomerus (Thomas).

This squirrel has been recorded from Ichang, Hupeh, and Sinyang, Kweichow, to the southwest. Mr. Zappey obtained three specimens from Hupeh, one at Tongkowshih, and two from Changyanghsien. Two of the skulls measure as follows: — greatest length, 57, 56.3; basal length, 44, 42; nasals, 19, 19.3; zygomatic breadth, 31, 30; interorbital constriction, 17, 16; upper diastema, 13, 13.4; upper tooth row (excluding p^3), 9.2, 9; lower molars, 9.8, 10.

Dremomys pernyi (Milne Edwards).

Twelve specimens of this species were obtained by Mr. Zappey in the mountains of western Szechwan at the following localities: — Tachienlu, 9,000 feet; Nachuka, 12,000 feet; Ramala Pass, 12,500–13,000 feet; and Shuowlow, 13,000 to 14,000 feet. Milne Edwards's specimens came also from Szechwan and "les montagnes de la principauté de Moupin, où elle paraît fort rare." Six adults were measured by the collector as follows: —

No.	*Sex.*	*Total Length.*	*Tail.*	*Hind Foot.*
7571	♂	312	119	48
7573	♀	328	150	50
7575	♂	335	150	50
7576	♂	345	153	52
7579	♀	350	150	50
7580	♂	350	156	49

Styan (in DeWinton and Styan, 1899) records this squirrel from western Hupeh, northern Kweichow, Anhwei, northwestern Fukien, and Yünnan, and states that it is a mountain species, probably not descending below 3,000 feet. Two specimens collected by Mr. Zappey in the neighborhood of Ichang, Hupeh, however, are quite different from our series of *D. pernyi*, and are here described

as a new species, although it may eventually be found that intergradation takes place between these eastern and the typical western representatives of the high altitudes. Possibly also Styan's remarks apply in part to the undescribed species.

DREMOMYS SENEX, sp. nov.

Type:— Skin and skull, No. 7582 M. C. Z., female adult, from Nantow, Ichanghsien, Hupeh, China. February 5, 1909, Walter R. Zappey.

General Characters:— Nearest to *D. pernyi*, from which it differs in its greater size, with notably longer tail and larger skull, in having the postauricular patch white instead of deep ochraceous buff, and the median area of the ventral surface of the tail nearly uniform clay color instead of whitish.

Color:— Forehead, top of head, neck, outer surface and anterior margin of ears, dorsum, and external surfaces of fore and hind feet a uniform grizzled olivaceous, the separate hairs with a plumbeous base, succeeded by one or often two narrow rings of buff which are separated by a slightly longer black ring. The tips of the hairs are black and in the dorsal region there are a few scattered hairs entirely black. Sides of the muzzle nearly clear gray; a poorly defined eye ring of buff; cheeks washed with buff. Postauricular spots *clear white*. Ventral surface of body from chin to anus and the inner surface of the limbs, white washed with buff, especially on the outer edge of the thighs. The white hairs of the chin and throat are very slightly gray at their bases, but those of the rest of the under parts have the bases dark slate color. Anal region, posterior edge of thighs and base of tail below, light orange rufous. Tail above mixed black, pale buff, and white, the separate hairs ringed at the base with very pale buff, then black, then buff, followed by a longer black ring and a grayish white tip, that forms a bordering fringe. Ventrally the color is similar except that the hairs of the central area of the tail are *buff* or *clay color*, slightly grizzled by the black rings, and quite without the long white hairs that in *D. pernyi* predominate in this area.

Skull:— The skull is similar to that of *D. pernyi* but slightly larger as shown by the measurements below.

Measurements:— The collector's measurements of the type are:— total length, 373; tail, 171; hind foot, 54. A second specimen from Ichanghsien, No. 7583, ♂, measured:— total length, 375; tail, 176; hind foot, 52. The skull of the type shows the following dimensions (the figures in parentheses are those of a large specimen of *D. pernyi*):— greatest length, 53 (51); basal length,

43 (41); palatal length, 25 (23.8); nasals, 17 (14.3); zygomatic breadth, 27 (27); mastoid breadth, 20.3 (20); interorbital constriction, 14 (13.8); greatest breadth outside m^3, 12 (11); upper diastema, 12 (12); mandible from condyle to tip of incisor, 36 (35); upper molar row (excluding p^3), 9 (9); lower molar row, 9.3 (8.7).

Remarks:— Apart from its greater size and differently colored tail, the most striking characteristic of this squirrel is the *white* postauricular patch. In our series of *D. pernyi* from Szechwan, as well as in Milne Edwards's plate (Rev. mag. zool., 1867, ser. 2, 19, pl. 19) and description, the bright ochraceous buff of these patches is a marked feature.

Sciurotamias davidanus (Milne Edwards).

A series of nine squirrels of this curious genus proves to be of considerable interest. Milne Edwards originally described *Sciurus* (*Tamias*) *davidanus* from the environs of Pekin and pointed out the peculiar cranial characters which seem to ally it to the chipmunks (Tamias). Through the courtesy of the United States National Museum, I have been loaned a topotype of this squirrel which agrees well in color with that described by Milne Edwards. In his remarks under the head of "*Sciurus pernyi*," this author (Recherches, p. 304–305) briefly describes, "*Sciurus consobrinus*" which he contrasts with the first-named species, stating that in cranial characters it is almost exactly the same as *S. davidanus* and evidently of the same "type spécifique." This squirrel came from the principality of Moupin and is said to differ from *S. davidanus* from Pekin in the possession of the reddish tones of the upper surfaces. The brief description given is sufficient to indicate the characteristic differences that separate the uniformly grizzled pale ochraceous and black squirrel of Pekin from the more western highland form with the posterior part of the back darker and redder, in contrast to the grayer tint of the shoulders. These differences have been well described by Dr. J. A. Allen (1909, p. 428) who names this darker form *Sciurotamias owstoni*, on the basis of six specimens from Taipasiang, Shensi. Through the kindness of Dr. Allen I have been enabled to compare this series with our material from Hupeh, and there seems no doubt that the name *consobrinus* is applicable to the dark reddish-backed form of which *S. owstoni* therefore becomes a synonym. Two of our specimens from Mafuling, Hupeh, (5,000 feet) seem to be nearer *S. davidanus* than to the race *consobrinus*, and are here referred to that species. A specimen from Tanshuiya, (3,000 feet) is also practically

identical. Thomas (1911) mentions a specimen from 40 miles north of Kaichow, southern Kansu.

Sciurotamias davidanus consobrinus (Milne Edwards).

Sciurotamias owstoni J. A. Allen, Bull. Amer. mus. nat. hist., 1909, **26**, p. 428.

In western Hupeh, and doubtless through northern Szechwan and into Shensi this darker, reddish-backed race of David's Squirrel is found. Four specimens of our series from Chiliping, Fongshan, Moshuiping, and Hsienshanhsien are certainly representative of this subspecies, and are identical with *S. owstoni* from Shensi. Thomas (1911, p. 169) has recently recorded other specimens from Omeishan and from 23 miles south of Tachienlu. There is much variation in the extent of the median white area on the throat. It is apparently lacking or practically so in one of the specimens from Hsienshanhsien, but in the other covers nearly the whole throat. In two others it is more restricted, and appears in one as a narrow median streak. In the series of six specimens of "*owstoni*," two have this white patch well marked, while in the type and one or perhaps two of the others it is represented by a mere fleck.

Sciurotamias davidanus thayeri, subsp. nov.

Type:— Skin No. 8008 M. C. Z., male adult, from Washan, western Szechwan, China, at an altitude of 6,000 feet. May 17, 1908, Walter R. Zappey.

General Characters:— Similar to *S. d. consobrinus*, but much richer and darker colored throughout, feet blackish, ears (in the type) nearly without white postauricular patches; pelage very long and full.

Color:— Sides of the throat, cheeks, muzzle, and upper surface of head as far as a line joining the bases of the ears a rich orange-ochraceous, nearly clear at the sides of the throat and nose, but elsewhere mixed with a nearly equal amount of black. An indistinct black stripe from below the eye to below the ear; a sharply defined buff eye-ring. External surfaces of the ears seal-brown, the postauricular white patches so restricted as to be unnoticeable. The upper surface of the body is a finely grizzled mixture of black and orange-ochraceous in which the black so predominates as to produce a very much darker color than in the previous subspecies, and in the back there is a practical absence of the reddish tone, though the shoulders are ticked with a slightly paler shade of ochraceous which tends to be more conspicuous in a longitudinal line from behind each ear producing a short and very ill-defined stripe. The hands and

feet are seal-brown to blackish above, the former with a very slight admixture of ochraceous hairs.

Ventrally the colors are richer and darker than in *consobrinus*, the dark of the sides encroaching nearly to the mid line of the venter and on the inside of the limbs. Chest and mid ventral area washed conspicuously with tawny-ochraceous; the bases of the hairs slaty. Median area of the throat pure white.

The basal fifth of the tail is colored above like the back; the rest is nearly clear tawny with a black border and an outer fringe of white. The ventral surface is similar but the tawny median area is partly obscured by long black hairs tipped with white.

Measurements:— The type was measured in the flesh by the collector as follows:— total length, 363 mm.; tail, 148; hind foot, 54.

Remarks:— This very well-marked race will probably prove to be confined to the Washan Mountains, whose peculiar conditions and isolation seem to have induced the differentiation of a number of local races or species. Unfortunately the skull of the type was lost, and no other specimens were obtained. It appears, however, to be sufficiently well characterized for recognition, and I have named it in honor of Col. John E. Thayer through whose generosity the collection was made possible.

Tamiops macclellandi swinhoei (Milne Edwards).

A single specimen of this prettily striped species was collected at Tachiao, western Szechwan, September 20, 1908, at an altitude of 12,000 feet.

Milne Edwards based his description on specimens from the "principauté de Moupin." Our specimen is thus practically from the same locality, and since I have found no good description of the species I append the following particulars.

Forehead and crown a grizzled gallstone-yellow and black; nape, shoulders, flanks, and upper side of limbs olive becoming lighter on the sides and passing into raw umber on the rump. Five black stripes on the back, the median dorsal beginning on the nape, becoming broadest in the middle region of the back, then narrowing to the base of the tail. A shorter but equally broad black stripe on each side from shoulders to rump, the intermediate space clay color. A broad clear stripe of pale ochraceous succeeds this black stripe laterally, on either side and is bordered by a short and ill-defined blackish line; inner surface of the ears pale ochraceous, outer surface bordered by black and provided with an erect fringe of long white hairs. A buff line runs from the muzzle, below the eye to the posterior base of the ear, and there is a narrow eye-ring of the same

color. Below, the color is grayish washed with buff, particularly on the throat and mid-ventral line. The tail is colored a mixture of black and raw umber with a narrow buff border and a black tip.

Collector's measurements:— total length, 248; tail, 107; hind foot, 33. The skull measures:— greatest length, 38.5; basal length, 30; palatal length, 17; zygomatic breadth, 21; interorbital constriction, 12.5; mastoid breadth, 16.6; mandible from condyle to tip of incisor, 25; upper molar row (excluding p^3), 6.9; lower molar row, 7.

Bonhote (1900, p. 52) in his synopsis of the squirrels of the *macclellandi* group considers this a subspecies, though Trouessart in his "Catalogus" retains it as a species.

Sciurus castaneoventris bonhotei Robinson & Wroughton.

A series of eight specimens collected at the extreme western border of Szechwan, at altitudes of from 10,000 to 13,000 feet, in Nachuka and Ramala Pass, probably represents this newly described race. It seems closely related to *Sciurus castaneoventris* of the southeast coast of China in the province of Fukien. In his original description of that species Gray states that "the ears are gray." The strikingly orange-rufous ears of our series together with the pale dorsal coloration seem to characterize it distinctly, although in their brief diagnosis, Robinson and Wroughton make no comparison with other races.

Matschie (1908, p. 210) has shown that the squirrel described by Hilzheimer (1905) as *Sciurus tsingtauensis* is really the same as *S. c. ningpoensis* for it since appears that the skin on which it was based came from the hills near Ningpo, instead of from Tsingtau, to the north, as supposed.

Six adults were measured in the flesh by the collector as follows:—

No.	*Locality.*	*Total. Length.*	*Tail.*	*Hind Foot.*
7826	Ramala Pass	405	200	55
7828 *Type*	Nachuka	405	185	53
7829	Nachuka	407	195	53
7830	Nachuka	417	185	53
7832	Ramala Pass	390	184	53
7833	Nachuka	390	170	54
	Average	402	186	53

The skull of the type measures:— greatest length, 51.8 mm.; basal length, 43.8; palatal length, 24.5; zygomatic breadth, 30.5; interorbital constriction, 17.6; mastoid breadth, 22.9; upper diastema, 11.5; mandible from condyle to tip of incisor, 35.5; upper molar row, 10.2; lower molar row, 10.

Pteromys albo-rufus Milne Edwards.

A trade skin of this beautiful flying squirrel was obtained by Mr. Zappey in the Province of Hupeh in 1907. It is identical in color with Milne Edwards's fine plate 45 (Recherches hist. nat. mammifères).

FELIDAE.

Felis ingrami Bonhote.

I have identified with this species a skin without skull obtained by Mr. Zappey at Changyanghsien, Hupeh, in January, 1909. In color it is similar to the specimen described by Bonhote (1903, p. 374) from the Wanchinshan Mountains in the neighboring province of Kweichow with which it further agrees in the shortness of the tail compared with the length of head and body. Bonhote gives for dimensions:— head and body, 480; tail, 200; hind foot, 75. Our skin measures (dried) much the same, except that the hind foot seems longer, but exact measurements are now impossible to obtain.

Felis scripta Milne Edwards.

A skin of a fine male from Suifu, western Szechwan, agrees well with Milne Edwards's figures and description of the type from the same province, in the principality of Moupin.

Felis pardus fontanieri (Milne Edwards).

Two partially dressed leopard skins were obtained by Mr. Zappey from the King of Tachienlu, western Szechwan. These seem undoubtedly to represent Fontanier's Leopard, described by Milne Edwards from the neighborhood of Pekin. The fur is thick and woolly, and the general color above is very pale, nearly buff-yellow of Ridgway, agreeing well with the plates in Milne Edward's "Recherches." One of these skins measures approximately 1800 mm. from muzzle to tip of tail, and the tail alone measures about 760 mm.; in the second and larger skin these measurements are approximately 1950 mm. and 640 mm. Milne Edwards gives 1920 and 750 for these two measurements respectively.

The black spots in our skins are apt to be somewhat brownish due to the length of the chocolate-colored bases of the hairs. In the larger specimen, the black areas on the back are somewhat confluent producing a very confused and mottled pattern.

The thick woolly fur of this leopard is indicative of its high mountain habitat in Szechwan.

Cabrera (1910, p. 426) attempts to show that Gray's name *japonensis* should replace *fontanieri* on the ground that Gray's specimen came probably from North China instead of Japan, a conclusion that may prove well founded; but the name is inapplicable since it was previously employed by Boddaert for a variety of the house cat.

Felis pardus variegata (Wagner).

In the Yangtze valley, at Changyanghsien, Hupeh, Mr. Zappey shot a fine adult male leopard, which is clearly a very different animal from *fontanieri* of the Szechwan highlands. Compared with our skins of the latter from Tachienlu it is larger and much richer in color, with more deeply black spots. The dorsal tawny areas are between ochraceous and orange-ochraceous paling to buff on the flanks. The spots are more sharply defined and of a deeper shining black. The hair, too, notwithstanding that this is a winter specimen killed February 2, 1909, is comparatively much shorter (26 mm. in length mid-dorsally between the shoulders as against about 40 in *fontanieri*) and without the woolly underfur of the latter. The black hairs are only very inconspicuously chocolate-colored at their extreme bases. The collector's measurements of this specimen in the flesh are:— total length, 2080; tail, 850; hind foot, 260; height at the shoulder, 610. The skull is large and heavily built and does not appear to differ remarkably in general proportions from that of *fontanieri*. It measures:— greatest length from occiput to front of incisors, 228; condylobasal length, 201; zygomatic breadth, 152; greatest breadth across supraorbital processes, 73; greatest length of mandible, 151; length from back of upper molar to front of canine, 71; length from back of lower molar to front of canine, 80.

This leopard probably represents the race inhabiting the lowland portion of southeastern China and I have provisionally referred it to *F. p. variegata*, whose range is supposed to be "Indo-China, Java, Sumatra" (Trouessart). That the leopard of the coastal region of southeastern China is different from those of India and North China was long ago pointed out by Swinhoe (1870, p. 628), who says, "judging from skins procured at Canton, the Chinese race is of a much richer yellow colour, and has the spots larger and blacker than is usually seen in skins from India."

VIVERRIDAE.

Viverricula pallida (Gray).

A female from Ichang, Hupeh, agrees well with Bonhote's (1898, p 119) description. The black collar is lacking on the under side of the throat, which is uniformly colored like the belly. Above is a narrow black stripe on each side of the neck, and an indistinct median one. The shoulders are without stripes or spots, but the lower back and rump have five or six well-marked narrow, black stripes. Matschie (1908, p. 198) has described as a new species *Viverricula hanensis* on the basis of a skin from Hankow. It is said to differ from *V. pallida* through the absence of a cross stripe on the shoulder and the possession of six well-marked longitudinal stripes on the back and eight instead of six dark rings on the tail. Our specimen has six rings with an indication of a seventh, but otherwise does not materially differ from this description, though the longitudinal stripes on the back might be considered as five, six, or seven owing to the indistinctness of the outer ones. In view of the great variation in color of these animals, as pointed out by Bonhote, and the fact that no cranial characters are mentioned by Matschie, it seems best for the present to consider the Ichang specimen as *V. pallida*. Its mesurements, taken by the collector, are:— total length, 830; tail, 290; hind foot, 91.

The skull measures:— greatest length, 95; basal length, 88; zygomatic breadth, 42; mastoid breadth, 30; length of bulla, 20; mandible from condyle to tip of incisor, 65; upper tooth row (exclusive of incisors), 37; lower tooth row (exclusive of incisors), 41.

CANIDAE.

Vulpes vulpes waddelli Bonhote.

A trade skin from Lhassa, Tibet, seems to be of this race, which according to Bonhote, differs from *V. v. flavescens* of northwest India in having the middorsal area a bright red in contrast to the rest of the upper surface. In *flavescens* this portion is more uniform and of a more brownish yellow.

Nyctereutes stegmanni Matschie.

Professor Matschie has briefly characterized several geographical races of the Raccoon dog from eastern Asia in his report on the mammals of the

Filchner expedition. In addition to *N. viverrinus* and *N. albus* from the Japanese islands, he recognizes *N. procyonides* of Gray from east central China (of which he makes *N. sinensis* Brass, 1904, "Nutzbare Tiere Ostasiens," a synonym) and describes as new *N. ussuriensis* and *N. amurensis* from Siberia, and *N. stegmanni* from the Yangtze basin. The last is said to differ from *N. viverrinus* in having the bases of the woolly hairs on the back blackish gray instead of reddish gray, the shoulders ticked with whitish gray on a dark ground instead of being blackish brown, while the sides of the body are not much darker than the clear band back of the shoulder. In size, the Yangtze animal is superior, being 82 cm. instead of 70 cm. in total length.

The skin of a single female, without skull, obtained by Mr. Zappey in December, 1908, at Suifu, western Szechwan, agrees well enough with Matschie's description of *N. stegmanni*. The dried skin measures about 82 cm. in total length. The general color is pale buff, clear on the sides of the neck, behind the shoulders, and on the lower surfaces of the body and tail, but elsewhere is mixed with black particularly on the mid-dorsal area and on the terminal half of the tail above. The lower limbs and patch below the eye are dark chocolate and the chin and throat are tinged with the same. No doubt further material will show intergradation between these described species.

MUSTELIDAE.

Lutreola moupinensis Milne Edwards.

A male and a female from Tachiao (12,000 feet) and a second female from Washan (9,000 feet), western Szechwan, are in the collection, the two former in summer pelage, the latter in winter. The two summer skins were taken on the 17th and 20th of September respectively and are essentially similar in coloration, a nearly uniform Vandyke-brown above, darkest on the forehead and muzzle shading into pale cinnamon on the ventral surfaces. The extreme tip of the tail is a seal-brown or blackish with one or two white hairs. The female in freshly assumed winter pelage, October 28, 1908, is cinnamon above, slightly darker along the median line, shading into a clear buff below. These specimens measured by the collector are as follows:—

No.	*Locality.*	*Sex.*	*Length.*	*Tail.*	*Hind Foot.*
7834	Tachiao	♂	543	198	59
7835	Tachiao	♀	428	156	37
7836	Washan	♀	432	167	49

The dimensions of the skulls of Nos. 7834 and 7835 are respectively:— greatest length, 62.8, 49.8; basal length, 57.5, 46; palatal length, 28, 22.6; interorbital constriction, 14.5, 11.8; zygomatic breadth, 33.5, 25.5; mastoid breadth, 30.8, 22.3; length of mandible from condyle to tip of incisor, 36.5, 28; upper tooth row from back of molar to front of canine, 19, 15.4; lower tooth row from back of molar to front of canine, 22.6, 18.

Lutreola sibirica (Pallas).

Three males and a female of this mink were taken at Ichang, Hupeh. They appear to agree in size with measurements given for more northern examples and the adult male skull seems identical with that from Chefoo, figured of natural size by Milne Edwards in his "Recherches," except that the pterygoids may be longer than there shown. The dimensions of these specimens, as noted by the collector are:—

No.	*Sex.*	*Length.*	*Tail.*	*Hind Foot.*
7104	♂	565	200	70
7105	♂	585	195	65
7107	♂	600	200	70
7106	♀	495	172	50

The cranial measurements of ♂ 7105 and ♀ 7106 are respectively:— greatest length, 65.5, 55; basal length, 60, 51; palatal length, 29, 23.2; length of audital bulla, 19.7, 17.5; zygomatic breadth, 34.4, 26.8; mastoid breadth, 30.5, 24; mandible from condyle to tip of incisor, 39, 30.6; upper tooth row from back of molar to front of canine, 19.5, 16; lower tooth row from back of molar to front of canine, 22.8, 18.

In the female, No. 7106, the lower first incisor on the left side is so reduced as to be hardly more than half the width of its fellow on the opposite side.

Swinhoe (1870, p. 624) records this species from Tientsin, Amoy, south China, and Formosa and states that it lives in the walls of houses, in most of the Chinese towns, feeding on rats and snakes.

Matschie (1908, p. 150) has described *Lutreola stegmanni* from Kiaochow on the Shantung Peninsula from four skins without skulls. Our specimens agree more or less with his description and may be referable to this form if it prove to be sufficiently characterized.

Martes flavigula borealis (Radde).

A perfectly typical skin of this race was obtained from the Chinese traders, probably from Hupeh or to the northwest.

Arctonyx leucolaimus Milne Edwards.

A trade skin, probably from Hupeh, is in the collection.

URSIDAE.

Ailurus fulgens styani Thomas.

A fine male skin, unfortunately without skull, from the Chinchiang Valley, western Szechwan, represents this race, recently described from Yanglinpa in the northwestern part of the same province. The collector's measure of the foot is 125 mm.; Thomas gives 112 for the foot without claws.

Ursus thibetanus macneilli (Lydekker).

The black bear of eastern Tibet has recently been described by Lydekker (1909) as a distinct race with a longer pelage and different skull as compared with its nearest geographic representatives of the Indian Himalayas. The skull is actually and proportionally broader, the palate is narrower and distinctly vaulted, instead of plane, and the third lower molar is narrower. The type is a skin and skull from Tachien, eastern Tibet, and the describer mentions also a female skull from Szechwan, in the collection of the British Museum. Mr. Zappey secured an adult skull somewhere near the eastern border of Szechwan which bears out the characters claimed for this subspecies. The palate is narrow and slightly vaulted and corresponds closely in measurements with those given for the type. The dimensions follow, together with those published for the type specimen in parentheses (here reduced to millimeters):— basal length, 264 (251.5); zygomatic breadth, 197 (170.2); length of three last upper cheek teeth, 64 (54.1); last upper molar, length, 29.2 (24.9); width, 15.5 (15.2); length of three last lower cheek teeth, 59.2 (55.4); last lower molar, length, 17 (15.5); width, 12.4 (10.7); length of penultimate lower molar, 21.6 (20.3). Our specimen is probably a male.

TALPIDAE.

Uropsilus soricipes Milne Edwards.

This species was described from specimens collected by Père David in the principality of Moupin, and has been recorded by Pousargues (1896, p. 1) from the northern part of Yünnan. Mr. Zappey obtained a series of nine specimens

from Washan, Lianghokow, and Tachiao, all in western Szechwan, at altitudes of from 3,000 to 12,000 feet. The skins are very uniform in color and agree closely with the excellent figures by Milne Edwards. The collector's measurements of the fresh specimens show the following extremes: — total length, 127–, 155 mm.; tail, 59–72; hind foot, 14–17.5; average of nine specimens, 137, 65 and 16 mm., respectively for these three dimensions.

The tooth formula of this species was supposed by Milne Edwards to be $I\frac{2}{1}\,C\frac{1}{1}\,P\frac{2}{3}\,M\frac{3}{3}$. Thomas (1912), however, in a series of specimens from Omisan found that the formula included *four* upper premolars and two lower incisors; and although in other respects the specimens showed no differences, he founded for them the genus and species *Rhynchonax andersoni*. Curiously enough, our series shows still a different formula. All the specimens have a large and a second minute lower incisor, as in "Rhynchonax"; but four have *three*, and three others have a *fourth* upper premolar. It would seem that the variation is individual rather than generic, since the two variations occur in specimens from the same locality that are otherwise identical. I prefer to regard these as variants of a single species, which is in process of losing the minute upper third premolar and the small lower incisor, and which in the individual presence or absence of these teeth shows parallelism with numerous similar cases among the Chiroptera.

SORICIDAE.

Anurosorex squamipes Milne Edwards.

A fine series of this almost tailless shrew was secured from Washan, in western Szechwan, and a few additional specimens are from Hupeh, at Hsien-shanhsien, 4,500 feet, and Changyanghsien, 5,500 feet. These all show a close agreement among themselves, and average smaller than the measurements given by Milne Edwards for the type, as will appear from the following table which includes, first the dimensions of the type, then those of three specimens from Hupeh: —

	Type	*Hupeh 7227* ♂	*Hupeh 7228* ♀	*Hupeh 7226* ♀
Total length	110	100	98	98
Tail	9	10	10	11
Hind foot	16	15	15	15
Length of skull	27	24	25.5	—
Greatest breadth of skull	15	—	13.2	—
Upper tooth row	13	11.2	12	11.7
Lower tooth row	12	10	11	10.7

The average of twenty-five specimens from Washan measured by the collector is: — total length, 102 mm.; tail, 12; hind foot, 15, with extremes, total length: 86–104; tail, 9–15; hind foot, 14–16.

Milne Edwards's specimens came from the mountains and plains of Szechwan and Tibet. He describes the pelage as "d'un gris uniforme tirant un peu sur le brun verdâtre" and his excellent figure is colored in this way. Our specimens show an additional color character of which he makes no mention. In thirteen skins taken in late October and early November, there is present on either side of the head, at the auricular region, a small ochraceous patch in marked contrast to the otherwise dark gray coat. If our specimens are all correctly sexed (sometimes not an easy matter in this group) this coloring is more frequent in the males, since nine of the thirteen thus marked are of this sex, while of fifteen females, but five show the patch on both sides, five others have it more or less distinct on one side only, and the other five females as well as three males do not show it.

Four specimens taken between the 18th and 29th of May seem to be acquiring the summer pelage which is shorter and more blackish without the silvery sheen of "brun verdâtre," when viewed from behind. Two of these collected May 28th and 29th respectively, seem still to retain the long rump hairs of the winter coat, that project as a conspicuous tuft nearly hiding the tail, while the other two, taken May 18th and 28th respectively, show no such contrast, but appear to have quite shed the winter coat.

Crocidura attenuata Milne Edwards.

A single specimen of this shrew was taken at Ichang, Hupeh, and agrees well with Milne Edwards's diagnosis. The color above is gray washed with a light tint of Prout's brown; below, uniform silver-gray, the tail bicolor like the body. The ears are prominent, their surfaces minutely haired; the longer hairs of the tail are relatively few and confined to the proximal three fourths. As shown in Milne Edwards's figure, the second upper unicuspidate tooth is smallest, the third slightly larger and the first largest. The dimensions of our specimen follow, as well as those of the type from Moupin in parentheses: — total length, 115 mm. (122); tail, 50 (48); hind foot, 13 (14). Skull: total length, 20 (21); mastoid width, 9; width outside second upper molar, 6.6; mandible from condyle to tip of incisor, 12.8; upper tooth row, 9; lower tooth row, 8.4.

Thomas (1911, p. 168) has recently recorded it from Kansu.

Crocidura coreae Thomas.

A single specimen of a small Crocidura was taken by Mr. Zappey at Ichang, Hupeh, which, if not identical with *C. coreae* is at least very closely related to it. Thomas (1907, p. 860) described the species from material collected at Min-gyong, 110 miles southeast of Seoul, Korea. Later he (1908a, p. 639) reported specimens from the Imperial Tombs, 65 miles east of Pekin, China. Our specimen appears to extend its known range south into the Yangtze valley. It was taken January 24, 1908, is broccoli-brown above, slightly mixed with grayish, below pale ecru-drab, tail colored like the body. As stated by Thomas the longer bristly hairs of the tail are numerous and extend nearly to the tip. The ears are prominent and minutely haired. Its measurements are as follows, with those of the type corresponding in parentheses: — total length, 98 mm. (95); tail, 40 (37); hind foot, 13 (11.5). Skull, greatest length, 17.5 (17.5); basal length, 15.5 (15.1); mastoid width, 7.7 (8.2); width outside second upper molars, 5.3; mandible from condyle to tip of incisor, 10.8; upper tooth row, 7.9 (7.8); lower tooth row, 7.0.

ERINACEIDAE.

Erinaceus ? hanensis Matschie.

I have provisionally referred to this newly named species a skin with skull from Ichang, Hupeh. The single specimen on which Professor Matschie bases the species came from Hankow, about 175 miles farther east in the same province. The original description contains little that is particularly diagnostic, and the distinction is based wholly on color. The spines are said to be of two sorts, whitish and light brown, the latter with long, dark horn-colored tips. These spines are about 25 mm. long. The color of the ventral side, of the head and of the limbs is a deep hair-brown, sprinkled with gray hairs on the sides of the body, on the limbs, breast, flanks, cheeks, chin, and nose. The claws are dark horn-color. The ears are dark and very small.

Our specimen is apparently immature though probably nearly full grown. The wholly white spines are more numerous near the periphery of the spiny area, but occur also in the mid-dorsal region, where there are a few wholly dark spines of nearly a broccoli-brown. Most of the spines are of a similar color at the base with a subterminal white band and a brown tip. The hair of the lower surfaces, head, and limbs is stiff and rather sparse but instead of being hair-brown is very pale vinaceous buff, darker on the forehead and the upper surfaces of the feet.

About the eye is a narrow ring of hair-brown, and a few dark brown hairs are scattered along the sides of the body. Without additional specimens it is impossible to decide how great may be the individual or age variation in color so for the present it seems best to consider this Ichang specimen as representing *E. hanensis*. The collector's measurements are: — total length, 225 mm.; tail, 19 mm.; hind foot, 43 mm.

The skull seems to be that of a nearly adult animal, and is but a trifle smaller than that of *E. dealbatus* from Pekin. Its dimensions are:— greatest length, 49.5; basal length, 46; palatal length, 29; zygomatic breadth, 30; mastoid breadth, 24; width outside first upper molar, 20; mandible from condyle to tip of incisor, 39; upper tooth row, 27; lower tooth row, 25.5. The anterior prolongations of the frontals do not reach the intermaxillaries so that there is a maxillonasal suture of some 3.5 mm. in length.

VESPERTILIONIDAE.

Pipistrellus abramus (Temminck).

Between July 24 and August 5, 1907, a series of twenty-five specimens was collected at Ichang. A number of these are immature with the metacarpal epiphyses still distinct. The species was also obtained at Kiating, Hochinghsien and Kweifu, in Szechwan. The adult males are nearly hair-brown above and females are of a redder tinge, nearly 'Prout's brown.' In both sexes the bases of the hairs are darker, near seal-brown. This sexual dichromatism was noticed by Swinhoe (1870, p. 618) who says that "the female is a rich brown, with lighter and dusky underparts; the male is black." The skulls of our series show some variation in size, though this is often more apparent to the eye than the measurements would indicate. Thus the smallest skull is 13 mm. long but is in every way lighter and more delicate than the largest which measures 14 mm. In some the upper canine and pm^3 actually touch, while in others there is a considerable space between the two teeth. Usually, however, this space is slight.

Vespertilio murinus superans (Thomas).

One male was taken at Ichang, Hupeh, April 22, 1907, and a pair on March 28, 1908, at Kweifu, in eastern Szechwan.

Nyctalus noctula labiata (Hodgson).

An immature skin and skull from Ichang, July 21, 1907, and an adult skin from Kweifu, eastern Szechwan, March 28, 1908, represent a very dark colored

race of the noctule bat, to which I have provisionally applied Hodgson's name. "*Vespertilio labiata*" was very briefly described by Hodgson in the Journal of the Asiatic society of Bengal, 1835, **4**, p. 700, from the "central region of Nipal," as "saturate brown throughout; skin wherever denuded purpurescent." "Teeth $\frac{2.2}{6}\ \frac{1.1}{1.1}\ \frac{6.6}{6.6}$; snout to rump three inches; tail two." It is said to be "closely affined to M. Geoffroy's *noctula*," with which Dobson, in 1878, considered it synonymous. Jerdon, four years previously had done the same, and in his "Mammals of India" gave its measurements as:— length $4\frac{1}{2}$ to 5 inches; tail, nearly 2; forearm, $1\frac{10}{12}$ = about 46 mm. Barret-Hamilton has recently described under the name of *P. montanus* a noctule bat from Mussoree, northwestern Himalayas, to which Hodgson's name may be applicable although its measurements seem a trifle less (forearm 42.5 mm.). Our two specimens from Hupeh and Szechwan are very similar to *P. noctula*, but darker throughout, nearly Prout's brown above and slightly paler below, the hairs practically unicolor to their bases. The immature specimen from Ichang is slightly the darker with a faint gloss to the upper surface. It is also albinistic in that the tips of both ears are white. The adult from Kweifu measures:— forearm, 49 mm.; thumb, 8; second metacarpal, 52.5; third metacarpal, 52.5; fourth metacarpal, 50.5; fifth metacarpal, 42. The forearm of the immature specimen measures 46 mm.; its skull is similar to that of *P. noctula* with the first upper premolar very small (not fairly prominent as in *P. leisleri*) and hidden in the angle between the canine and the upper second premolar.

RHINOLOPHIDAE.

Rhinolophus minor Horsfield.

Four specimens from Kiating, Szechwan, taken November 29, 1908, agree closely with the description and measurements given by Andersen in his review of the species of this group (Proc. Zool. soc. London, 1905, **2**, p. 126–128). The forearm measurement is 38 mm. In all, pm_3 stands practically in the tooth row.

Rhinolophus rouxi sinicus Andersen.

This race was described from a single specimen taken at Chinta, Anhwei, on the lower Yangtze. Mr. Zappey obtained two specimens of a Rhinolophus belonging to the *simplex* group, at Ichanghsien, Hupeh, that undoubtedly represent the same race but are even smaller than the type, with forearms 43 and 44

mm. respectively, against 46. They represent a light and a darker phase, the former between russet and wood-brown above, the latter a drab. The following cranial measurements show that the skulls are a trifle smaller than that of the type:—

	Type.	*No. 7223.*	*No. 7224.*
Total length of skull to front of canine	19.8	19	18.5
Upper tooth row " " " "	7.7	7.5	7.
Lower tooth row " " " "	8.1	8.	7.3
Mandible	13.5	12.8	12.5

In both specimens the first upper premolars are in the tooth row on each side. In No. 7224 lower premolars 2 and 4 are in contact, with premolar 3 forced to the outside in the angle between them. In No. 7223, however, lower premolar 3 is only slightly external and separates the two others by a slight space.

CERCOPITHECIDAE.

Macacus lasiotis Gray.

A young female of this short-tailed baboon was obtained in the mountains of western Szechwan, at Nachuka, 10,000 feet. The fur is fine and silky, of an olivaceous tint on the head, brightening to nearly clear pale orange-ochraceous on the hips. The feet and fore limbs are grayish. The collector's measurements are :— total length, 515 mm.; tail, 156; hind foot, 125.

REFERENCES.

Allen, J. A.

1909. Mammals from Shen-si Province, China. Bull. Amer. mus. nat. hist., **26**, p. 425–430.

Anderson, M. P.

1909. Description of a new Japanese vole. Ann. mag. nat. hist., ser. 8, **4**, p. 317–318.

Barrett-Hamilton, G. E. H.

1900. On geographical and individual variation in *Mus sylvaticus* and its allies. Proc. Zool. soc. London, 1900, p. 387–428, pl. 25.

Bonhote, J. L.

1898. On the species of the genus Viverricula. Ann. mag. nat. hist., ser. 7, **1**, p. 119–122.

1900. On squirrels of the *Sciurus macclellandi* group. Ann. mag. nat. hist., ser. 7, **5**, p. 50–54.

1903. On a new species of cat from China. Ann. mag. nat. hist., ser. 7, **11**, p. 374–376.

1905. The mammalian fauna of China.— Part 1. Murinae. Proc. Zool. soc. London, 1905, **2**, p. 384–397.

Cabrera, A.

1910. Sobre los nombres especificos y subespecificos de algunos "Felis." Bol. Real soc. Española hist. nat., p. 423–428.

Hilzheimer, M.

1905. Neue chinesische säugetiere. Zool. anz., **29**, p. 297–299.

1906. Eine kleine sendung chinesischer säugetiere. Abh. und berichte Mus f. natur- und heimatkunde Magdeburg, **1**, p. 165–184, pl. 2–4.

Lydekker, R.

1904. The Ichang tufted deer. Proc. Zool. soc. London, 1904, **2**, p. 166–169, text-figs. 32, 33.

1905. The white-maned serow. Proc. Zool. soc. London, 1905, **2**, p. 329–331, pl. 8.

1908a. The Sze-chuen and Bhutan takins. Proc. Zool. soc. London, 1908, p. 795–802, pl. 43, figs. 168–171.

1908b. On two Chinese serow-skulls. Proc. Zool. soc. London, 1908, p. 940–944, text-figs. 191, 192.

1909. On the skull of a black bear from eastern Tibet, with a note on the Formosan Bear. Proc. Zool. soc. London, 1909, p. 607–610, figs. 186, 187.

Matschie, P.

1908. Wissenschaftliche ergebnisse der Expedition Filchner nach China und Tibet, 1903–1905. Mammalia. Berlin, **10**, p. 134–244, pl. 5–25.

Milne Edwards, H., and A.

1868–1874. Recherches pour servir à l'histoire naturelle des mammifères. Paris, 394 pp., 105 pls.

Pocock, R. I.

1908. Notes upon some species and geographical races of serows (*Capricornis*) and gorals (*Naemorhedus*), based upon specimens exhibited in the Society's gardens. Proc. Zool. soc. London, 1908, **1**, p. 173–202, fig. 30–38.

Pousargues, E. de.

1896. Sur la collection de mammifères rapportés du Yun-nan par le Prince Henri d'Orléans. Bull. Mus. d'hist. nat. Paris, p. 1–4.

Swinhoe, Robert.

1870. Catalogue of the mammals of China (south of the river Yangtsze) and of the island of Formosa. Proc. Zool. soc. London, p. 613–653, fig. 1–8.

Thomas, O.

1898. On mammals collected by Mr. J. D. La Touche at Kuatun, N. W. Fokien, China. Proc. Zool. soc. London, 1898, p. 769–775.

1902. On the Panda of Sze-chuen. Ann. mag. nat. hist., ser. 7, **10**, p. 251–252.

1907. The Duke of Bedford's zoological exploration in eastern Asia.— II. List of small mammals from Korea and Quelpart. Proc. Zool. soc. London, 1906, **2**, p. 858–865.

1908a. The Duke of Bedford's zoological exploration in eastern Asia.— VI. List of mammals from the Shantung Peninsula, N. China. Proc. Zool. soc. London, 1908, **1**, p. 5–10.

1908b. The Duke of Bedford's zoological exploration in eastern Asia.— X. List of mammals from the Provinces of Chih-li and Shan-si, N. China. Proc. Zool. soc. London, 1908, **2**, p. 635–646, pl. 32.

1908c. On the generic position of the groups of squirrels typified by "*Sciurus*" *berdmorei* and *pernyi* respectively, with descriptions of some new oriental species. Journ. Bombay nat. hist. soc., **18**, p. 244–249.

THOMAS, O.

1908d. Note on the squirrel-genus "Zetis." Ann. mag. nat. hist., ser. 8, **2**, p. 136.

1909. The Duke of Bedford's zoological exploration in eastern Asia.— XI. On mammals from the provinces of Shan-si and Shen-si, northern China. Proc. Zool. soc. London, 1908, **2**, p. 963–983.

1910. A collection of small mammals from China. Proc. Zool. soc. London, p. 635–638.

1911. The Duke of Bedford's zoological exploration of eastern Asia.— XIII. On mammals from the provinces of Kan-su and Sze-chwan, western China. Proc. Zool. soc. London, p. 158–180.

1912. The Duke of Bedford's zoological exploration of eastern Asia.— XV. On Mammals from the Provinces of Szechwan and Yunnan, western China. Proc. Zool. soc. London, p. 127–141.

WINTON, W. E. DE, and STYAN, F. W.

1899. On Chinese mammals, principally from western Sechuen. Proc. Zool. soc. London, p. 572–578, pls. 31, 32.

PLATE 1.

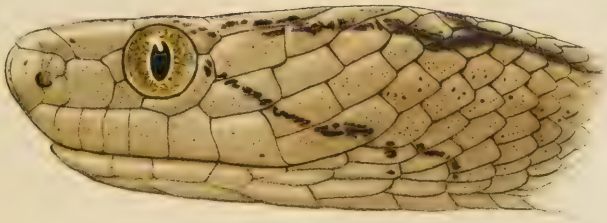
PLATE 1.

Fig. 1.— *Batrachypterus sinensis* (Sauvage). Page. 126.
Fig. 2.— *Hyla monticola*, sp. nov. Type, M. C. Z. No. 2553. Washan, western Szechwan. Page 127.

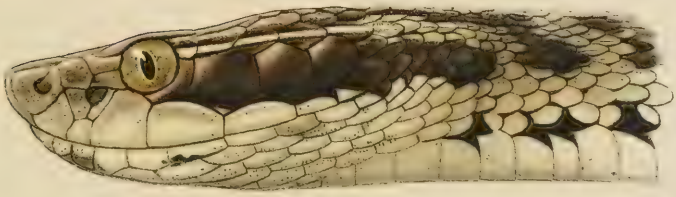
PLATE 2.

PLATE 2.

Fig. 1.— *Amblycephalus chinensis*, sp. nov. Type M. C. Z. No. 7326. Luluping, western Szechwan. Page 132.
Fig. 2.— *Agkistrodon blomhoffii brevicaudatus* Stejneger. Page 132.
Fig. 3. *Agkistrodon tibetanus*, sp. nov. Type M. C. Z. No. 7327. Ramala Pass beyond Tachienlu, western Szechwan. Page 133.
Fig. 4.— The same.

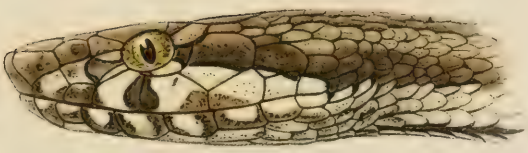


1



2

3



4

PLATE 3.

PLATE 3.

Fig. 1.— *Rallus aquaticus korejewi* Saruduy. M. C. Z. No. 52601. Ichanghsien, Hupeh, March 8, 1908. Page 144.

Fig. 2.— *Niltava lychnis* Thayer & Bangs. Type, M. C. Z. No. 50001. Patung, Hupeh, May 19, 1907. Page 163.

2

1

PLATE 4.

PLATE 4.

Fig. 1.— *Pnoepyga mutica*, sp. nov. Type M. C. Z. No. 51974. Washan Mountain, western Szechwan, June 3, 1908. Page 172.

Fig. 2.— *Suthora zappeyi*, sp. nov. Type M. C. Z. No. 50738. Washan Mountain, western Szechwan, November 3, 1908. Page 171.

2

1

PLATE 5.

PLATE 5.

Fig. 1.— *Tesia grallator*, sp. nov. Type M. C. Z. No. 51975. Washan Mountain, western Szechwan, May 31, 1908. Page 169.

Fig. 2.— Bill of *Tesia grallator*.

Fig. 3.— Bill of *Tesia castaneocoronata* (Burton). Page 170.

Fig. 4.— *Prinia inornata exter*, subsp. nov. M. C. Z. No. 52578 Kiating, western Szechwan. Adult male in winter plumage. Page 183.

Fig. 5.— *Prinia inornata exter*, subsp. nov. Type M. C. Z. No. 52580, Hokow, western Szechwan, May 4, 1908. Adult male in spring (breeding) plumage. Page 182.

5
4
1
2
3

PLATE 6.

PLATE 6.

Boanerges internigrans, sp. nov. Type M. C. Z. No. 52587. Shuowlow, western Szechwan, August 23, 1908. Adult male. Page 200.

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XL. No. 5.

ZAGLOSSUS.

BY

GLOVER M. ALLEN.

With Two Plates.

CAMBRIDGE, U.S.A.:
Printed for the Museum.
October, 1912.

CONTENTS.

	Page
INTRODUCTION	253
HISTORY AND NOMENCLATURE	253
EXTERNAL CHARACTERS	255
Measurements	260
MUSCULATURE	260
Muscles of the Skin	260
Muscles of Head and Neck	263
Caudal Muscles	266
Muscles of Thorax and Abdomen	267
Muscles of Throat and Larynx	269
Muscles of the Fore Leg	270
Muscles of the Hind Leg	276
VISCERAL ANATOMY	284
Digestive Tract	284
Mesenteries	286
Spleen	286
Kidneys and Genitalia	286
Lungs	286
PLEXUSES	287
OSTEOLOGY	288
Skull	288
Vertebrae	295
Ribs	297
Girdles and Limbs	298
Spur	301
HABITS	301
SUMMARY AND CONCLUSIONS	302
BIBLIOGRAPHY	305
EXPLANATION OF THE PLATES	

ZAGLOSSUS.

INTRODUCTION.

Since its discovery in 1876, specimens of the Long-beaked spiny anteater of New Guinea have been rare in collections. Hitherto the osteology of but a single specimen has been completely known, and of the anatomy of the soft parts practically nothing has been published. No less than five forms have been described, but the validity of most of these seems questionable, and even the genus itself is by some considered unworthy of recognition.

The Museum has lately acquired seven specimens, four skins with skulls and three alcoholics, which together with a mounted skin purchased many years ago, and a mounted skeleton kindly loaned by the United States national museum, appear to constitute all the available material in America. On the basis of this material I have prepared the following review of the history and characters of this interesting monotreme.

HISTORY AND NOMENCLATURE.

Peters and Doria (1876) based their original description of the Proechidna on a cranium from Mt. Arfak, northern New Guinea. It lacked a large part of the posterior end as well as the lower jaw, but from its strikingly long and curved rostrum as compared with that of the Australian Echidna, they considered it a new species and named it *Tachyglossus bruijnii*. In the Annual record of science and industry for 1876, p. clxxi, published about May 5, 1877, Gill called attention to this new and remarkable animal and proposed for it the generic name Zaglossus (see Palmer, 1895). Gervais, in November, 1877, unaware of Gill's paper, likewise considered it generically distinct from Tachyglossus and named it Acanthoglossus, which he shortly discovered was preoccupied by Acanthoglossa for a genus of insects. He accordingly renamed it Proechidna, under which title it has become generally known. Indeed the name is so well established that it seems best to retain it in a vernacular sense, as well as the

name Echidna for Tachyglossus. Dubois (1881) considered Acanthoglossus sufficiently distinct from Acanthoglossa but in case this view were not accepted, he proposed the name Bruynia instead, with *tridactyla* as the specific name. In the Zoölogical record for 1882, Thomas amends this to Bruijnia, and adopts the combination *Bruijnia bruijnii*, though in the year following he reverts to *Proechidna bruijnii* which is the name finally used in his Catalogue of the Marsupialia and Monotremata in the British museum (1888). More recently, in conformity with his adherence to the 'one-letter rule,' Mr. Thomas (1907) has considered *Acanthoglossus bruijnii* the correct name, but Palmer (1895) has called attention to the name Zaglossus of Gill, which though long overlooked, must evidently take precedence if the Proechidna be considered generically distinct from the Echidna. On this latter point there has been much difference of opinion, but as later detailed, there seems sufficient ground, as modern generic conceptions go, to keep the two apart.

There is still some doubt as to the number of local races or species of Proechidna in New Guinea. Under the name *Proechidna villosissima* Dubois (1884) figured and described an animal from northern New Guinea which he believed to represent a second species. It was evidently an immature specimen from its small size (total length, 390 mm., rostrum 61), had a nearly straight beak, and a very woolly thick pelage of a uniform dull brown. The spines are described as white and needle-like, not exceeding 19 mm. in length, and almost completely hidden in the fur, except that their extreme tips project from the woolly covering at the sides of the neck and in the caudal region. There were sixteen pairs of ribs, one less than recorded by Gervais, but a number probably normal for the genus as I shall later show. Owing to the evident youth of this specimen it has been regarded by most authors (and I think rightly) as merely an immature *bruijnii*. Gill (1885) in calling attention to his earlier use of the name Zaglossus, includes *Zaglossus villosissimus* as a second species of the genus, but evidently he had not seen a specimen. Rothschild (1892) considered it a variety of *bruijnii* and later (1905) in reviewing the genus recognized it definitely as a subspecies of that animal. This review was based on a study of nine specimens, more than had previously been brought together by any investigator. Rothschild believed that three forms were recognizable: — (1) *Zaglossus bruijnii* with brownish black or black hair, and white spines; (2) *Zaglossus bruijnii villosissima* with pale brown hair, thick, long, and woolly, hiding the spines except on flanks and shoulders; and (3) *Zaglossus bruijnii nigroaculeata*, described by the same author in 1892 as *Proechidna nigroaculeata*, which has uniformly dark, long, thin, and

bristly hair, and black somewhat flattened spines. No cranial characters are given as the specimens were unaccompanied by separate skulls.

In 1907, Thomas obtained a specimen of this genus from Mt. Victoria, British New Guinea, at an altitude of 8,000 feet, the first known from this portion of Papua. It was an old female, but the cranial measurements, though large, do not exceed those of Gervais's larger specimen. This specimen is made the type of *Acanthoglossus bruijnii bartoni* and is briefly characterized as having fur long and thick, entirely hiding the spines over the whole of the dorsal area except on the nape, sides of the neck, flanks, back of rump, and caudal region. The general color is black throughout except the hands and feet which are brown grizzled with whitish. The spines are white, thin, not exceeding 30 mm., and are absent from the belly. It is not clear how this is to be distinguished from the race *villosissima*, except that it is black instead of brown. This difference, however, is probably individual. In the same year Thomas (1907a) described *Acanthoglossus goodfellowi* as a new species from the island of Salawatti. This specimen was obtained from the natives who may quite readily have brought it to this island from the adjacent shores of New Guinea. Salawatti is a rather low island separated from Papua by a narrow stretch of mud-flats, and its fauna so far as known is not different from that of the Papuan mainland. The species is said to be easily recognizable by the predominance of the spines and the almost entire suppression of the woolly coat. The longest spines are some 30 mm. in length, and are white shading basally to gray. The fur is short and scanty, of a uniform black throughout. The skull presents no marked peculiarities. All these characters are shown in one of our Papuan examples, so that there seem to be no grounds for recognizing a Salawatti race, even in case it should be true that the animal naturally occurs there and was not carried thither by the natives. Thus though there are currently recognized five varieties of the Proechidna the validity of more than the one species is open to serious question.

EXTERNAL CHARACTERS.

In the eight specimens in the collection of the Museum of Comparative Zoölogy all the characters claimed for these described races are to be found in various combinations, yet there seems no good reason for recognizing more than one form among them. The color of *Z. bruijnii bruijnii*, as stated by Rothschild, is brownish black or black. The head may be paler than the body, or in albinistic individuals may be more or less white. No. 6,722 M. C. Z. is

partially albinistic. It has the head from the base of the rostrum back nearly half the distance to the ear opening, white, a white spot on the right side in front of the shoulder, another on the left side behind the shoulder, and an irregular series of marks on the rump. It is evident that such marks are of no taxonomic value in the present case. No. 7,398 M. C. Z. is a topotype from Mt. Arfak, and is preserved in alcohol. The face, forehead, limbs, and belly are a dark Vandyke brown, darkening to seal-brown over the dorsal region. The fur is thick and woolly, but the spines project conspicuously above it. These spines are uniformly blackish with white tips, are short on the occiput but large over the back, shoulders, and caudal region where the longest reach nearly 37 mm. They encroach slightly on the sides of the venter, but are few and scattered on the belly. Thomas (1907a) says that in *bruijnii* the belly is without spines throughout but this is hardly the case in any of the specimens I have examined. In its possessing black spines this specimen resembles "*nigroaculeata*," but it is not so thinly haired as Rothschild describes. The flattened character of the spines in this supposed race is unquestionably the result of wear. For in an old specimen, M. C. Z. 12,414, many of the dorsal spines are worn quite to the small hollow center and have become beveled off nearly flat on their dorsal surface. This old specimen consists of a skin and skeleton from Fak Fak, New Guinea. The hair and spines are greatly worn and so scattered that the skin is everywhere visible. The general color of the hair on the fore part of the head is a pale buffy, but on the dorsal part of the body the scattered bristles are blackish or blackish brown. Those on the ventral surfaces are a more decided brownish, near Prout's brown. On the fore limbs are a number of grizzled whitish hairs with the brown. Of the spines, almost all are white throughout but a few, on the shoulders, back, and hips are blackish, with pale bases. The ventral spines are short and are distributed from the axilla nearly to the groin. They are arranged in rather definite curved rows, the most anterior passing posteriorly and dorsally, the later rows curving laterally from the axilla, then in towards the groin. These ventral spines reach to within 25 mm. of the midline. This large specimen is apparently identical in general characters with that described by Thomas (1907a) as *Acanthoglossus goodfellowi* from the island of Salawatti. There can be little doubt that both are simply old animals with the hair either much worn or partly shed. Of much interest in our specimen is the fact that among the large worn spines are scattered other smaller ones, sharp-pointed and unworn, that appear to be new spines coming in.

In 12,415, M. C. Z., an adult also from Fak Fak, the spines are large, stout,

prevailingly white, and almost unworn, the longest reaching 44 to 47 mm. on the rump. The coarse brown hair which covers the upper part of the body rather thickly, has the appearance of being much worn and broken allowing the spines to project nearly their entire length, with the result that the animal appears much more spiny than those in which the hair is unworn and covers the bases of the spines.

Two specimens from Sorong, New Guinea (M. C. Z. 7,009, 7,010), presented by Dr. Thomas Barbour, agree in having the hair of the body nearly coal-black, with the bases more or less brownish. The larger spines vary from dark horn color to blackish, the smaller ones are entirely black save for a few very small spines on the occiput which are white. The venter is nearly free from spines.

It seems evident from a study of the material in the collection of the Museum, that the characters claimed for the races *nigroaculeata* and *goodfellowi* are individual or the result of age and wear. Moreover no geographical limits are established for these variations. So, unless other and more distinctive characters can be found, it seems unnecessary to consider these as valid races.

With regard to the race *villosissima* there seems also room for much doubt. The original specimen described by Dubois (1884) appears from its measurements to have been immature, which would account for its short and nearly straight rostrum. The chief character claimed for it is the long and woolly hair, completely hiding the spines except on the sides of the neck and in the caudal region. It appears, however, that the longest spines did not exceed 19 mm., which is about half the length of those of adult *bruijnii*.

The collection of the Museum contains a Proechidna from Mt. Arfak, M. C. Z. 7,397, the type locality of *bruijnii*, that agrees with the description of *villosissima* in having the pelage notably thick and woolly. The spines, however, are slightly longer than described for *villosissima* (21 to 24 mm.) and although most prominent on the shoulders and rump, project slightly above the hairy coat. They are black, or black with light tips, instead of white as described. The skull shows the specimen to be very immature, and it is undoubtedly the youngest of the eight skulls examined. In almost every respect it is identical with immature skulls of *bruijnii*, but differs from all those studied in that the anterolateral terminations of the large interparietal are each in contact with one of the nasals. In the four other specimens of *bruijnii* in which these bones are still traceable, the interparietal does not abut against the nasals, although in two cases, the distance separating the two bones is not over 5 mm. Probably therefore this character is merely individual. Rothschild

(1905) states that in his series of nine Proechidnas are specimens even more thickly haired than Dubois claimed for the type of *villosissima*, but adds that he and Dr. Hartert differed as to which should be considered young animals, for there was no way of comparing the skulls. The dense character of the pelage may be retained in the adult, as is the case apparently of the specimen from British New Guinea, made the type of the race *bartoni* by Thomas. The thickness of the hairy coat can not of itself be considered a specific character since even the small series of specimens at hand shows much variation in this respect. Possibly the extreme condition shown by the *villosissima* specimens is in part a concomitant of youth, as has been suggested by earlier writers. The lack of definitive cranial characters, together with the absence of trenchant differences in external features or geographical range, seems sufficient ground for relegating *villosissima* to synonymy under *bruijnii*.

To recognize four or five races of Proechidna all of which may occur together in the western peninsula of Papua seems a rather anomalous proceeding, particularly since these are not separated by any structural peculiarities. The case is somewhat paralleled by that of the Australian Echidna in which the range of variation is so great as to have led at various times to the recognition of several races, although now but one form is accorded to that continent. While I have not seen the type of either *bartoni* or *goodfellowi*, a careful study of the descriptions of these two races does not reveal any diagnostic characters, and it seems best to consider these names for the present, at least, as synonyms.

As long ago as 1868, Krefft reported the discovery of Echidna-like remains in the Wellington bone and breccia caves of New South Wales, Australia, and he figured a portion of a humerus. Later, Owen made further reports on additional fragments discovered in these caves. He figured a nearly complete humerus that appears to belong to Zaglossus rather than to Tachyglossus as I shall later show. This important discovery points to the former coexistence of the two genera in Australia, and is of special interest in its zoögeographic bearing, since at the present day both are found in New Guinea; but the Echidna alone survives in Australia. It follows therefore that the Proechidna was already well differentiated from the Echidna long before Papua was sundered from Australia, so that it is not a recent Papuan derivative from an Echidna stock, developed here through isolation. But rather the two genera have long existed side by side.

The distinctive characters of the Australian fossil Proechidna are insuffi-

ciently known, so that although doubtless enough to entitle it to separate rank I am unable here to give them in detail.

I would recognize but one living form of Proechidna and one fossil, with the following synonymy.

Zaglossus bruijnii bruijnii (PETERS and DORIA).

Tachyglossus bruijnii PETERS and DORIA, Ann. Mus. civ. storia nat. Genova, 1876, **9**, p. 183.
Zaglossus bruijnii GILL, Ann. rec. sci. and industry, 1877, p. clxxi.
Acanthoglossus bruijnii GERVAIS, Compt. rend. Acad. sci. Paris, 1877, p. 837.
Proechidna bruijnii GERVAIS, Ostéogr. des monotrèmes, 1877 '78, fasc. 1, p. 43.
Bruynia tridactyla DUBOIS, Bull. Soc. zool. de France, 1881, **6**, p. 266.
Bruijnia bruijnii THOMAS, Zool. record, 1882, **19**, Mammalia, p. 40.
Echidna (*Acanthoglossus*) *bruijnii* MURIE, Journ. Linn. soc. London, 1879, **14**, p. 413.
Echidna bruijnii FLOWER and GARSON, Cat. Mus. roy. coll. surgeons, pt. 2, 1884, p. 753.
Proechidna villosissima DUBOIS, Bull. Mus. roy. hist. nat. Belg., 1884, **3**, p. 110.
Proechidna nigroaculeata ROTHSCHILD, Proc. Zool. soc. London, 1892, p. 545.
Zaglossus bruijnii villosissima ROTHSCHILD, Novitates zoologicae, 1905, **12**, p. 305.
Zaglossus bruijnii nigroaculeata ROTHSCHILD, Novitates zoologicae, 1905, **12**, p. 305.
Proechidna novaeguineae and *Proechidna leucocephalus* ROTHSCHILD, Proc. Zool. soc. London, 1892, p. 546 (*nomina nuda*, quoted from a dealer's catalogue).
Acanthoglossus bruijnii bartoni THOMAS, Ann. mag. nat. hist., 1907, ser. 7, **20**, p. 293.
Acanthoglossus goodfellowi THOMAS, Ann. mag. nat. hist., 1907, ser. 7, **20**, p. 498.

Habitat: Papua.

† **Zaglossus oweni** (KREFFT).

Echidna owenii KREFFT, Ann. mag. nat. hist., 1868, ser. 4, **1**, p. 114.
Echidna ramsayi OWEN, Phil. trans. Roy. soc. London, 1884, **175**, p. 273.

Extinct: Australia, New South Wales; remains in Wellington bone and breccia caves.

Attention may be called at this point to the studies of Toldt (1905, 1906) on the hair and spines of the Proechidna. He points out what may fairly be considered a generic difference in the character of the spines of the Proechidna as compared with the Echidna. For while in the latter they are thin-walled, with a relatively large lumen and long tapering point, in the Proechidna they are blunter and much more solid, with a very small central lumen. Toldt shows that a light-colored spine may have a concealed layer of dark pigment near its core; other spines are without pigment, and others again appear dark-pigmented. This, however, is a matter of individual variation for both light and dark spines may occur in the same animal or one or the other sort may predominate. The color of the spines, on which Rothschild seems mainly to have based his race *nigroaculeata*, can therefore have no systematic significance in this case. Toldt, however, prefers to consider his dark-spined individual *nigroaculeata*. The transition from hairs to various forms of spines is well brought out by this

author, who illustrates such a transitional series by hairs and spines selected from different parts of the same animal.

Measurements.— The largest recorded Proechidna is that made by Rothschild (1892) the type of his *nigroaculeata*. This specimen measured in the flesh 31 inches (about 640 mm.) in total length. Dubois (1881) records an adult that measured 620 mm. from the tip of the snout to the tip of the tail. Two adult skins, M. C. Z., Nos. 12,414 and 12,415, measure 717 and 539 respectively, but there is no way of proving whether the specimens are overstuffed. Rothschild's measurement is probably nearly maximum for adults. Weber (1888) gives measurements taken from five skins but all are less than 640 mm.

The naked part of the rostrum in M. C. Z. 12,414, measures 101 mm. The claws of the left fore and hind feet measure:—

	Left fore foot.	Left hind foot.
Digit 2	22.6	47
Digit 3	27	38.7
Digit 4	25	28

The spur in this specimen is 7 mm. long.

A series of cranial measurements is given in the part of this paper dealing with the osteology.

MUSCULATURE.

Muscles of the skin.— As in the case of the Echidna, the *panniculus carnosus* is very remarkably developed, so as to form a loose muscular sac in which are imbedded the bases of the spines. By its contraction this muscle erects the spines, which thus form a bristling armament. Fewkes (1877) has described and named as separate muscles, several of the subdivisions of this enveloping sac in the Echidna, and the same divisions appear to be present in the Proechidna. Anteriorly the *panniculus* extends as far as the parietal region, whence its fibers extend diagonally forward just back of the eyes and pass transversely under the chin. Medially on the forehead there is a narrow space devoid of muscle fibers where the union of the two lateral portions of the muscle is by fascia only. There is an attachment also along the posterior part of the squamosal bone on each side. From the head, the fibers are continued on both dorsal and ventral sides of the body to the tail and laterally on to the legs. Dorsally the muscle is thickest midway between the median line and the ventral border of the body and forms a continuous sheet across the back where the

fibers of opposite sides, passing diagonally posteriorly and dorsally from the venter, meet along the median line. Here there is a narrow area devoid of spines that runs the length of the vertebral column. On the fore limbs the fibers extend to the carpus externally, but not quite so far on the radial side. They insert for a space of about 20 mm. on the distal ulnar margin and pass also into the fascia covering the hand. Posteriorly the fibers encircle the lower leg, below the knee and similarly become confluent with the fascia investing the extremity of the leg.

The following secondary attachments were found:— (1) a small muscular bundle, rather triangular in section, and divisible into two main strands, arises by a flat tendon from the posterior tuberosity of the head of the humerus, slightly internal to the insertion of the *pectoralis*, and passes dorsad and caudad some 65 mm. to the dorsolateral portion of the *panniculus*, with the fibers of which it becomes united. This is the *dermo-brachialis posterior* of Fewkes.

(2) A smaller and more nearly cylindrical muscle takes origin by a separate tendon just external to the last, from the posterior tuberosity of the humerus; it is of about the same length, but curves distinctly cephalad. Its fibers run forward into those of the *panniculus* at about the position of the large spines on the fore shoulder. Fewkes names this muscle the *dermo-brachialis anterior*.

(3) A thin sheet of muscle which appears to be the *dermo-cervicis triangularis* spreads over the back of the neck and inserts with the *panniculus* into the distal part of the ulna. The two muscles of opposite sides are continuous dorsally through a thin aponeurosis.

(4) What Fewkes has called a *dermo-dorsi cervicalis* in the Echidna exists also in Zaglossus (Plate 1, fig. 1, *m*). It arises just back of the shoulder by muscular strands from the eighth and ninth ribs, and is connected by aponeurosis with the posterior ends of the *trapezius* and the *latissimus dorsi*. These strands unite to form a flat muscle about 70 mm. long and 17 mm. wide at the point of insertion into the dorsal part of the *panniculus*. It passes anteriorly before uniting with the latter, and then expands to a width of some 34 mm. The muscles of opposite sides apparently do not unite to form an ellipse on the back such as Fewkes describes for the Echidna, but at their anterior approximation the two muscles are separated by about 10 mm. They are more or less intimately connected, however, with a thin sheet of non-muscular tissue that covers the dorsum. This sheet is attached along either side at about 30 mm. from the midline, from the eleventh rib and medially from the eleventh dorsal spine posteriorly. Toward the sides of the body it becomes thickened with fat and

finally forms a great layer of adipose tissue that extends from the axilla to the groin, next the body muscles.

(5) A very remarkable muscle, named by Fewkes the *dermo-flexor antebrachii*, arises by a series of digitations from the eighth to the thirteenth ribs (Plate 1, fig. 1, *ld*). The first of these is in contact with one of the slips of the *dermo-dorsi cervicalis*, at its ventral border. The entire muscle is somewhat fan-shaped and its fibers converge and pass to a tendinous insertion into the fascia investing the fore arm, about halfway on its ventral surface. Mivart (1866) considers this muscle a posterior portion of the *latissimus dorsi*, but as stated by Fewkes, its insertion is different, though its origin is similar. Mivart's supposition, however, has much to recommend it. From a lateral view it is seen that the origins of *latissimus dorsi*, *dermo-dorsi cervicalis*, and *dermo-flexor antebrachii* form a practically continuous series of digitations from the ribs, as is usual for the *latissimus*. What may once have been thus a single muscle, originating by digitations from the first to thirteenth ribs and inserting on the ulna, may quite conceivably have become broken into three sections, as here, the two posterior of which have become superficial in their attachments. The function of the middle portion (*dermo-dorsi cervicalis*) has thus become changed to that of a retractor of the bases of the dorsal spines, while the function of the posterior part (*dermo-flexor antebrachii*) is still practically that of the true *latissimus*, serving to approximate the fore arm while at the same time drawing it posteriorly. Owing to the great anteroposterior extent of the arm, the efficiency of the true *latissimus* is greatly lessened so that the transference of the insertion of this posterior portion from the ulna to near the carpal region results in a great gain of power for a burrowing animal.

(6) What are evidently the *dermo-extensores brachiales intimus, inferior, et superior* of Fewkes, are also present in Zaglossus as a narrow band of superimposed sheets about 10 mm. wide and 100 mm. long, from near the midline of the *panniculus* at the back of the neck, passing to the fasciated sheath that encircles the wrist and inserts on the ulna.

(7) A muscle named by Fewkes the *dermo-flexor cruris* (Plate 1, fig. 1, *dfc*) arises by a thin tendinous sheet from the spines of the coccygeal vertebrae, and is joined by a few fibers of the overlying part of the general *panniculus*. The broad sheet of muscle thus formed passes laterally and invests the lower hind limb where on the external aspect it becomes a thin sheath of aponeurosis and internally is muscular. From the distal part of this sheath a conspicuous muscle band is separated and passes to a tendinous insertion 7 mm. long on the

peroneal aspect of the tibia. A similar condition is described in the case of the Echidna by Fewkes.

Muscles of head and neck.— The muscles of the head appear to resemble those of the Echidna in all essential respects. The long snout is covered by thin hardened cuticle quite without any evident musculature. The muscles operating the lower jaw are also very poorly developed in correlation with the slight mobility of that member. There are therefore almost no facial muscles.

A thin flat muscle about 20 mm. wide arises by thin connective tissue from the parietal region under the anterior edge of the *panniculus* and passes to the posterior edge of the opening of the external ear. Its homology is not altogether certain.

The *digastric* muscle is a short narrow strand from the skull just anterior to the ear, to the posterior corner of the angle of the jaw.

The *masseter* is also inconspicuous, arising from the posterior half of the ventral margin of the zygomatic arch. It inserts in a shallow depression on the external side of the mandible from the angle of the jaw to a small prominence about 1 cm. in advance that may be considered a coronoid process. In the Echidna this muscle is described as considerably larger, with an origin about an inch in length, from a point "about half an inch in advance of the anterior edge of the orbital foramen."

The *temporalis* fills the posterior half of the orbit, where its origin is only about 1 cm. in length. It narrows to its insertion on the coronoid process.

Directly under and posterior to this is the *pterygoideus internus*, which arises from the skull by muscular fibers from the insertion of the *temporalis* to the glenoid cavity of the jaw. It inserts on the inner side of the jaw from the condyle to the coronoid process, and is about as large as the *temporalis*.

The *pterygoideus externus* is smaller and arises posterior to the *pterygoideus internus* and inserts on the inner side of the condyle of the jaw. The condition is apparently the same as in the Echidna, as minutely described by Lubosch (1906, p. 558). The homology of these muscles with the pterygoidei of other mammals is uncertain.

The *trapezius* muscles, as in the Echidna, consist of an anterior and a posterior. The former arises by a thin tendinous sheet from the entire midline of the neck and mainly from the side of the occiput, dorsal to the ear. It inserts along the dorsal half of the clavicle and the anterior edge of the scapula, where its fibers join those from the second or posterior portion at the anterodorsal

angle. Possibly this anterior part may represent an *acromio-clavotrapezius* The insertion seems to be slightly less extensive in the Echidna.

The posterior portion of the *trapezius*, perhaps the homologue of the *spino-trapezius* is a flat sheet, nearly an equilateral triangle in outline, arising by a very thin tendinous sheet from the dorsal spines of the tenth thoracic to the second lumbar vertebrae. It thickens greatly as it narrows to its insertion, some 20 mm. in length, on the anterior edge of the scapula (the region corresponding to the spine).

As in the Echidna, the *rhomboideus* is a single muscle, arising under the *trapezius* from the parietal margin of the skull, above and slightly in advance of the ear, nearly to the midline of the cranium, and posteriorly underneath almost the entire length of the *trapezius*. It thickens as it passes laterally to its insertion along the entire vertebral border of the scapula.

The *levator scapulae ventralis* arises by two heads:—(1) a slightly tendinous attachment from the basioccipital and (2) a strong muscle mass from the ventro-lateral portion of the atlas and axis. The insertion is at the anterior edge of the scapula at the point of union with the clavicle and thence dorsally for about 20 mm. Mivart (1866) in the Echidna did not note the extension of the origin to the axis, but otherwise the muscle appears to be similar.

The *occipitoscapularis* is a narrow ribbon-like muscle from the mastoid region just posterior to the ear. It is inserted along the vertebral edge of the scapula, beginning about 10 mm. from the gleno-vertebral angle and extending anteriorly about twice that distance. Apparently Mivart (1866) and Westling (1890) did not find this muscle in the Echidna.

The *cleidomastoideus* is wanting as in the Echidna.

The *latissimus dorsi* has already been mentioned in connection with the cutaneous muscles. It may be considered as consisting of three parts of which the most anterior only has the usual relations. This arises by six or seven digitations from the first seven thoracic vertebrae, and passes to a strong tendon that inserts upon the most posterior part of the tuberosity of the humerus. Its tendon is joined by that of a narrow muscle arising from the ridge on the scapula dorsal to the glenoid cavity. This latter muscle is of doubtful homology, and is found likewise in the Echidna where, however, it originates instead "from the posterior extremity of the vertebral margin of the scapula." Mivart calls it a *dorso-epitrochlear* (?), or possibly a separate portion of the *teres major*. Westling (1889, p. 14), however, considers it a part of the *latissimus dorsi* that is not homologous with any separate muscle in other animals. In support of

this view is the fact that a similar division sometimes occurs in man, as pointed out by the same author. If this view be correct, the Echidna furnishes an interesting transition stage between the usual condition in which the *latissimus* is from the vertebral column, and that in the Proechidna in which the supplementary muscle, arising in the Echidna from the vertebral edge of the scapula close to the origin of the main muscle, has instead become shifted about two thirds the distance to the glenoid cavity to take origin from the low ridge at that point. An additional peculiarity of this supplementary portion of the *latissimus* in the Proechidna is that at its origin from the low ridge above the glenoid cavity it becomes split into two. One of the branches is that just described passing to the tendon of the *latissimus;* the second passes laterally as a flat band to its insertion along the ectal margin of the olecranon of the ulna.

The *serratus magnus* is a large muscle, arising from the transverse processes of all but the first of the cervical vertebrae and from strips from each of the four most anterior ribs. It inserts along the vertebral edge of the medial side of the scapula, of which it covers practically the vertebral half. The longest of the digitations is that from the fourth rib, 38 mm. According to Westling, there is a digitation also from the fifth rib in the Echidna.

The *longissimus dorsi* and the *multifidus spinae* are so intimately fused as hardly to be distinguished as separate muscles. The former arises as a thick flat muscle from the head of the ilium and its fibers pass forward to the spines of the lumbar and dorsal vertebrae. The *multifidus spinae* is a series of thin imbricated sheets arising by tendinous fibers from the tips of the transverse processes from the second lumbar vertebra forward. All are closely connected into a single mass that unites the transverse processes to the spines and adjacent parts of the vertebrae, forward including the cervical vertebrae.

What is evidently the homologue of the *iliocostalis* (Plate 1, fig. 1, *ic*) arises by a thin sheet of fascia from the head of the ilium and from the spines of the lumbar vertebrae. It passes obliquely forward as a band some 15 to 20 mm. wide, to about the fifth rib, and on the thorax breaks into a series of short muscular bundles each of which connects the external surface of two adjacent ribs.

The *splenius* takes origin from very thin fascia covering the occiput and the neck as far back as the last cervical vertebra. At the midline the two muscles of opposite sides are continuous.

The *longissimus capitis* is a thicker muscle than the last and arises from the lateral processes of the last four cervical vertebrae. These two muscles have

a common insertion at the mastoid region just dorsal to the external ear and posterior to the insertion of the sternomastoid.

Beneath the *splenius*, and covering the back of the neck is the *biventer cervicis*, a broad muscular sheet, arising from the spines of the first thoracic and all the cervical vertebrae. It inserts by tendinous fibers along the dorsal part of the occiput corresponding to the lambdoid ridges.

The *rectus capitis posterior minor* is quite as large as the preceding and arises from the anterior margin of the atlas, dorsal to the transverse process. According to Fewkes, its origin in the Echidna is from the posterior rim of the atlas. In both it passes forward as a thin sheet to insert upon the posterior part of the occiput, somewhat ventral to the insertion of the *biventer cervicis*.

The *rectus capitis posterior major* was not identified, although it is said to be present in the Echidna as a very small muscle from the anterior extremity of the spinous process of the axis to the occiput.

The *obliquus inferior* originates from the lateral surface of the spine of the axis and passes forward as a strong muscle to insert into the dorsal part of the lateral process of the atlas.

The *obliquus capitis superior* is a short thick muscle, from the ventral side of the transverse process of the atlas to the occiput.

The *rectus capitis lateralis* lies just ventral to the last, and arises from the anterior face of the lateral process of the axis. It passes forward as a stout round muscle to insert just lateral to the insertion of the *obliquus superior*. Mivart states that in the Echidna this muscle has the usual relations, *i. e.*, from the atlas to the occiput, but in the Proechidna its origin is certainly from the axis.

The *longus capitis* arises from the ventral side of the transverse processes of the sixth and seventh cervical and first dorsal vertebrae. It passes forward along the side of the neck as a ribbon-like band, that becomes a flat tendon at the region of the axis and inserts into the jugular process of the skull, just posterior to the tympanic bone.

The *scalenus* is similar to that of the Echidna, arising from the transverse process of the second to seventh cervical, and inserting on the first rib.

Caudal muscles. — The dorsal muscles of the tail are so intimately connected that they are with difficulty separated into distinct bundles.

The portion corresponding to the *extensor caudae medialis* is of muscle fibers from the spines and dorsal surfaces of the last two lumbar and the succeeding vertebrae, and from the medial edge of the ilium; from this muscle mass, tendons pass to the articulating processes of the vertebrae.

More laterally, fibers arise from the articulating processes of the sacral vertebrae, and from the posterior part of the ilium and lateral part of the vertebrae. These fibers become partly tendinous as they pass dorsocaudad to insert on the dorsal parts of the posterior caudal vertebrae. This muscle is the *extensor caudae lateralis*.

Other and more numerous fibers arise similarly from the posterior margin of the ilium and the dorsal parts of the vertebrae ventral to the articulating processes. The muscle-mass thus formed appears to correspond in part to the *abductor caudae externus*. It passes back along the dorsolateral side of the tail and sends tendons to the anterior margins of the transverse processes of the vertebrae.

The ventral musculature of the tail consists of two main masses, a lateral and a medial, on each side. The former is from muscle fibers arising from the posterodorsal part of the ischium and from the ventral side of the caudal vertebrae adjacent. It forms a tapering bundle inserting by tendinous fibers into the ventral part of the transverse processes. It is probably the homologue of the *coccygeus*.

The more medial masses of muscles arise along the length of the sacral and caudal vertebrae on either side of the median line as a series of bundles that taper posteriorly. They insert by muscle fibers on the ventral part of the coccygeal vertebrae and by strong short tendons that pass to each of the chevron bones. This muscle-mass is probably homologous with the *flexor caudae longus* and the *flexor caudae brevis*.

From the transverse process of the third caudal vertebra a narrow band of muscle passes ventrally, beneath the rectum to join a similar muscle from the opposite side. They together form a muscle that probably corresponds to the *levator ani*. A few muscular fibers join this muscle to the preceding.

Muscles of thorax and abdomen.— The *sternomastoideus* originates by muscular and tendinous fibers from the midventral part of the broad lobe of the episternum. Proximally the muscle is flat and broad (about 20 mm. transversely) and is united by fascia to the corresponding muscle of the opposite side. It tapers as it passes forward to its insertion by a stout tendon at the mastoid region, just above the ear.

The pectoral muscles are essentially as in the Echidna. The *ectopectoralis* arises from the side of the manubrium beneath the origin of the *sternomastoideus*, and inserts by tendon on the pectoral ridge of the humerus. A second portion, corresponding to an *entopectoralis* is rather clearly distinguishable, arising

medially from the manubrium to the large third sternebrum. Its fibers pass likewise in a stout bundle to an insertion on the pectoral ridge of the humerus, slightly posterior and lateral to the insertion of the *ectopectoralis*. In the Echidna the separation of the *ectopectoralis* from *entopectoralis* seems much less clearly marked, if indeed, it is to be distinguished at all. A third portion seems to represent a *xiphihumeralis*. It arises as a narrow muscle at the median line, from the xiphisternum, whence it extends posteriorly about 25 mm. It passes obliquely forward and inserts on the pectoral ridge at the caudal end of the greater tuberosity of the humerus.

In addition to these, there is a large muscle that arises along the entire anteroventral edge of the clavicle from the articulation with the scapula nearly to the median line. Its insertion is likewise on the pectoral crest continuous with and slightly anterior to that of the *entopectoralis*. This muscle both Mivart and Westling find in the Echidna. The former considers it a part of the deltoid on account of its proximity to the acromion at the dorsal point of origin. This interpretation is accepted with some misgiving by Westling, who suggests that it may almost equally well represent a *clavopectoralis*, a view that seems quite as probable.

The abdominal muscles present no special peculiarities, but are essentially similar to those of the Echidna. The *rectus abdominis* is a strong band of muscle fibers some 20 mm. wide, from the base of the epipubic bone passing forward on each side to insert on the ventral prominence of the coracoid and on the ventral half of the first rib.

The *obliquus externus* is strongly developed, and overlies the posterior half or more of the preceding muscle. It arises from the anterior edge of the pubis and the epipubic bone, the tuberosity of the ilium and the lumbar vertebrae, and by a series of muscle strips from the second to the last rib. Each of these strips arises just proximal to the union with the sternal portion of the rib and hence the origins become successively higher dorsally, in passing posteriorly. These strips are all united by fasciae, and between the pubis and the thoracic basket the muscle forms a continuous sheet of fibers, that becomes thickest over the abdomen and is joined as usual to the corresponding muscle of the opposite side.

The *obliquus internus* is in intimate connection with the fibers of the *transversus abdominis* from which it is hardly to be separated. The latter is likewise closely connected with the *obliquus externus* along the lumbar and pelvic origin.

It extends forward along the margin of the thoracic basket to the well-defined *linea alba* at the midventral line.

Muscles of throat and larynx.— Fewkes is apparently right in supposing that Mivart has confounded the *sternoglossus* with the *sternohyoideus* and *sternothyroideus* in his account of these muscles in the Echidna. It is the most conspicuous of the throat muscles, and forms a stout round bundle on each side of the pharynx. It arises from the dorsal side of the xiphisternum and passes to the base of the tongue at the upper part of the pharynx, sending a few fibers to the stylohyoideus as it crosses the larynx. As shown by Fewkes in the case of the Echidna this muscle can be separated into two portions to which he gives names. In addition, there is in the Proechidna a small thin muscular band at about 25 mm. from the anterior end of the *sternoglossus* on its dorsal side, that passes posterodorsally some 30 mm. to the pharyngeal wall.

What appears to be a *sternohyoideus* arises in the Proechidna mainly from the dorsal side of the manubrium. It forms a single median muscle and inserts into the posterior end of the body of the hyoid. Westling attempts to homologize the *sternoglossus* of the Echidna with the *sternohyoideus* of other animals. Neither this author nor Fewkes mentions the median muscle here considered the *sternohyoideus*, nor is it clear that this muscle is present in a similar manner in the Echidna.

The *sternothyroideus* of the Proechidna likewise presents a few points of difference in comparison with that of the Echidna. It arises from the anterior dorsal edge of the manubrium instead of from the entire dorsal surface of the sternum. It passes forward as a thin band closely applied to the ventral surface of the *sternoglossus*. About halfway on its length it becomes tendinous and receives a short slip of muscle from the side of the sternohyoid. Continuing forward, it again becomes muscular and inserts into the side of the thyroid cartilage.

The *omohyoideus* is present as in the Echidna. It arises at the anterointernal edge of the middle portion of the scapula and tapers to its insertion at the anteroventral border of the thyroid.

The *stylohyoideus* is similar to that of the Echidna, arising from the jugular process just behind the ear. It expands greatly in passing back to its insertion at the midline of the larynx where it is joined by a raphe to the corresponding muscle of the opposite side.

The *geniohyoideus* is a rather narrow muscle from the symphysis to the anterior end of the larynx, where it expands to a width of some 15 mm. It is

largely hidden by the *mylohyoideus*, a thin muscular sheet from the posterior portion of the ramus, beginning some 15 mm. behind the symphysis. The two sheets of opposite sides unite medially by a raphe and insert at the anterior end of the larynx. The *myloglossus* is exposed by laying back the *mylohyoideus*. It is attached on the ventral side of the skull from near the base of the ear on its medial side, forward to the angle of the jaw. It joins the opposite muscle at the midline.

Muscles of the fore leg.— What appears to represent the *deltoideus* is present in both the Echidna and the Proechidna as a narrow band arising for a length of about 15 mm. along the anterior edge of the scapula, and at about the same distance dorsal to the junction of the acromion with the coracoid. It narrows to a round stout tendon, that passes anteriorly to the fore leg to its insertion on the anterior side of the tuberosity of the humerus underneath the insertion of the pectoral muscles. This muscle is what Mivart considers a second portion of the deltoid, whose main division he regards as the muscle from the clavicle to the pectoral ridge of the humerus. As already noted, the homology of this larger muscle is somewhat doubtful. From the fact, however, that in the Proechidna, its origin is wholly from the clavicle and its insertion is continuous with those of the other muscles of the *pectoralis* group, it seems better to consider it a *clavopectoralis*.

Owing to the fact that in monotremes the anterior edge of the scapula corresponds to the scapula spine of other mammals, the relations of the muscles in this region differ accordingly.

The *supraspinatus* arises from the entire medial surface of the scapula below the insertion of the *serratus*. It passes out beneath the acromion and episternum and inserts on the anterolateral extremity of the greater tuberosity of the humerus.

The *infraspinatus* takes origin from the ectal side of the scapula, from the anterodorsal angle to the acromion and nearly to the glenoid cavity. It inserts on the greater tuberosity of the humerus just posterior to the insertion of the *supraspinatus* and continuous with it. The condition of these muscles in the Echidna is quite similar.

The *subscapularis* occupies the entire posterior half of the ectal side of the scapula from the vertebral edge, posterior to the ridge above the glenoid cavity. It becomes tendinous and passes to the extremity of the lesser tuberosity of the humerus. From the ridge between it and the *infraspinatus* comes the long head of the triceps. Westling has described in the Echidna a *sub-*

scapularis accessorius which is present likewise in the Proechidna. The origin is directly over the center of the glenoid cavity. It passes ental to the *triceps* back to the lesser tuberosity of the humerus where it inserts just distal to the insertion of the *subscapularis*.

The *teres major* is a large flattened muscle arising from the extreme postero-dorsal angle of the scapula on the external side. It inserts on the humerus by a broad tendon slightly distal to the insertion of the subscapularis.

The *teres minor* is lacking in both the Echidna and the Proechidna. The small muscle described as *subscapularis accessorius* can hardly represent this muscle, on account of its insertion into the lesser instead of the greater tuberosity. According to Sabatier it is fused with the *infraspinatus* which seems extremely probable, since the latter is intimately connected along the anterior edge of the scapula, with the *supraspinatus* where the latter passes out beneath the episternum.

The *coracobrachialis* presents quite the same divisions as in the Echidna. The most superficial is the *caput longum* from the posterior tuberosity of the coracoid by a broad tendon. It passes as a broad muscular band to the internal distal condyle of the humerus where it is inserted by short tendinous fibers. Underneath this head, and from the same origin is the *caput breve*, which spreads out as a thin muscular sheet over the posterior aspect of the head of the humerus from the lesser tuberosity to the center of the depression between the two tuberosities, and distally for nearly three fourths the length of the humerus. The third portion is much smaller, and is wholly overlaid by the second head. It arises slightly anterior to the latter, in part from the lateral surface of the epicoracoid and passes as a short tenuous sheet to insert on the lesser tuberosity of the humerus just posterior to the insertion of *subscapularis*. This is the *epicoracobrachalis* of Coues.

The *biceps* arises from the ventral surface of the coracoid below the glenoid cavity. At its anterior edge may be separated off a small slip whose origin is from the epicoracoid. The two are closely approximated and after about 20 mm. become inseparably fused to form a stout muscle that passes to a tendinous insertion nearly a centimeter in length on the medial side of the radius, nearly the same distance distal from the sigmoid cavity. The same condition, essentially, is found in the Echidna in which the small slip from the epicoracoid is considered by Westling a second head. The action of the muscle is to approximate the fore arm to the breast.

The *triceps* is very strongly developed, and is separable into the usual

three divisions. The *caput longum* has origin by a short stout tendon just dorsal to the glenoid cavity of the scapula, at the ventral end of a small ridge. In the Echidna this origin is much more extensive, and is represented as continuing dorsally almost to the vertebral edge of the scapula. Also the deltoid and the small branch of the *latissimus dorsi*, previously noticed, are in the Echidna from nearer the vertebral edge, since their origin is slightly dorsal to that of the *caput longum*. The insertion of this muscle is as usual into the tip of the olecranon. The *caput laterale* arises by a stout tendon from the lateral face of the humerus at nearly the end of its proximal third. It inserts at the external corner of the olecranon, and is fused distally with the *caput mediale*. This last covers the entire posterior aspect of the humerus, from just below the head, to the deltoid ridge and inserts into the middle and medial borders of the olecranon beneath the *caput longum*.

The *brachialis* in the Proechidna is almost inseparable from the *brachioradialis*, along the medial side of which it is so closely applied as to be with difficulty separated. Its origin is just lateral to the anterior edge of the humerus at about the end of its proximal third. It passes to the ulna, on whose medial side it is inserted by a thin tendinous sheet just anterior to the sigmoid notch.

The *anconeus* (Plate 1, fig. 3, *an*) is a well-defined band some 30 mm. long that arises at the external border of the posterior distal tubercle of the humerus and passes anteriorly to the olecranon of the ulna where it inserts just posterior to the *caput mediale* of the *triceps*.

The *brachioradialis* is similar to that of the Echidna. It arises on the external side of the humerus, distal to the tendon of origin of the *caput laterale* of the *triceps*, and occupies nearly the middle third of the humerus. It passes as a thin sheet to a partly tendinous insertion along the medioventral border of the radius for some 25 mm. distal to the sigmoid notch. Its internal surface is very closely connected with the *brachialis*, which, however, is of about half the extent of the *brachioradialis* along the line of insertion.

The *extensor carpi radialis longus* (Plate 1, fig. 2, *erl*) is a narrow muscle, somewhat triangular in section, that arises from the lateral supracondyloid ridge of the humerus, just distal to the *brachioradialis*. Slightly beyond the middle of the radius it passes into a flat tendon that runs over the distal head of the radius and inserts upon the dorsal surface of the combined *radiale* and *intermedium* ("scapholunar bone").

The *extensor carpi radialis brevis* (Plate 1, fig. 2, *erb*) is of nearly four times the bulk of the *longus* and arises just external to it from the supracondyloid

ridge. It becomes tendinous at a point slightly more distal than the *longus*, and the tendons of both muscles pass together beneath the tendon of the *extensor brevis pollicis*, and along a slight groove on the distal head of the radius. The tendon of the *brevis* division becomes very flat and inserts on the dorsal side of the third metacarpal at its proximal end. The condition of these two muscles is thus quite the same as in the Echidna.

The *extensor digitorum communis* (Plate 1, fig. 2, *ed*) is likewise practically identical with that of the Echidna. It arises from two heads:— (1) a narrow muscular strip from the extreme anterolateral border of the external epicondylus and (2) a deeper muscle overlaid by the *extensor digitorum lateralis* and *extensor carpi ulnaris*. It arises along the proximal two thirds of the anterolateral border of the ulna medially to the line of contact with the radius from which also come a few fibers. Both heads unite at about two thirds the length of the fore arm and pass as a flat tendon along the depression between ulna and radius. On the carpus, the tendon divides into three branches, one each to the dorsal margin of the distal phalanx of digits 2, 3, and 4. In the Echidna, notwithstanding that the fifth digit is clawed and hence more functional as a digging organ than the clawless knob representing that digit in the Proechidna, the *communis* tendons are likewise three, one each to the same digits, although a fourth branch to digit 5 might have been expected.

The *extensor digitorum lateralis* (Plate 1, fig. 2, *el*) is a very thin narrow band arising by a flat tendon from the lateral epicondylus of the humerus and from the under side of the *extensor carpi ulnaris*, for about 6 mm. out from its proximal end. It is thus largely covered by this muscle and its flat tendon appears just proximal to the wrist, and passing over the hand, inserts at the proximal end of the terminal phalanx of digit 4, underneath the lateral branch of the *communis* tendon. In the Echidna the condition is quite similar.

The *extensor carpi ulnaris* (Plate 1, fig. 2, *eu*) is a flat muscle from a broad origin by tendinous fibers extending between the distal edge of the lateral epicondylus of the humerus to the dorsal edge of the base of the ulna. The muscle tapers to a strong round tendon that passes over the distal head of the ulna where it runs along a shallow groove to the outer edge of the hand and inserts as in the Echidna into the first phalanx of the fifth digit at the proximal end.

The *supinator* is a stout muscle, triangular in cross section, lying under cover of the *extensores carpi radialis et ulnaris*. It is inserted along the anterior surface of the proximal half of the radius.

The *extensor brevis pollicis* (Plate 1, fig. 2, *ep*) is essentially as described

for the Echidna, arising by tendinous fibers from the median edge of the ulna just distal to the sigmoid notch and by fibers from the ligament between ulna and radius. Proximally the muscle is closely applied to the *supinator*, and then passes as a stout flattened tendon across the tendons of the *extensores carpi radialis longus et brevis* to insert on the radial side of the first metacarpal.

The *pronator teres* (Plate 1, fig. 2, *pt*; fig. 3, *pt*) is strongly developed. It has origin by a flat tendon from the medial edge of the internal epicondylus of the humerus and is partly covered by the *flexor carpi radialis*. The muscle thickens in the middle, and becomes somewhat triangular in section. Distally it flattens again and inserts by muscular fibers along the medial edge of the radius from the insertion of the *biceps* to the epiphysis.

The *flexor carpi radialis* (Plate 1, fig. 3, *fr*) is a large, radially compressed muscle, arising from the anterior edge of the internal epicondylus of the humerus slightly external to the origin of the *pronator teres*, whose base it slightly overlaps. It passes into a stout tendon at the beginning of the terminal third of the fore arm and inserts into the proximal end of the second metacarpal, ventrally, and by a continuation of the tendinous portion it is likewise united with the first metacarpal. The condition is essentially the same as in the Echidna.

The *palmaris longus* is lacking, at least as a separate muscle. Mivart considers that it is fused in the Echidna with the *flexor profundus digitorum*.

The *flexor carpi ulnaris* (Plate 1, fig. 3, *fu*) is from two heads as usual:— (1) for nearly one third the length of the ulna from the olecranon along its ectal edge, (2) by a smaller flatter muscle arising at the ectal corner of the epicondyle of the humerus, where it partly overlies the most exterior head of the *profundus*. The ulnar head is the larger and the tendons of the two unite just proximal to the distal head of the ulna and insert as usual into the pisiform bone. Proximally the second head is united by a few fleshy fibers to the base of the *profundus*.

The *flexor sublimis digitorum* is lacking as a separate muscle.

The *flexor profundus digitorum* (Plate 1, fig. 1, *p*; fig. 3, *p*) is enormously developed and arises from four heads:— (1) an ulnar head, from the proximal two thirds of the inferior surface of the ulna and from fascia between the radius and ulna; (2) from the angle of the internal epicondylus of the humerus where it is partly covered by the second head of *flexor carpi ulnaris;* (3) a thick portion arising also from the internal epicondylus, just medial to the second portion of the *profundus*, to which it is intimately connected by muscular and tendinous fibers; (4) a deep lying slender and spindle-shaped muscle quite distinct from

the other heads and completely covered by them, which arises from the ectal border of the internal epicondylus under head 2 and passes into a tendon which unites with the main tendon at the wrist. The large common tendon covers the palm and at the base of the metacarpals divides into three strong flat tendons, one each to digits 2, 3, and 4. Each tendon runs along the inferior side of its digit, and just distal to the base of the metacarpal passes through a transverse loop. It inserts in the terminal phalanx of the digit. This muscle in the Echidna differs remarkably in that there are five divisions of the great tendon, one each to the five claws. According to Mivart each tendon likewise passes through a cross-loop at the metacarpal, except that of the pollex, but Fewkes found that division as well passed through a loop. In the Proechidna, therefore, the division into three instead of five tendons is correlated with the reduction of the clawed digits to three, showing that this difference is of a somewhat profound character, functional as well as anatomical, for there is no trace of the two lost branches to the now reduced first and fifth digits in the Proechidna. In all other respects, however, the muscles of the fore limb are essentially alike in the two animals. It would be interesting to know the condition of this muscle in the occasional specimens of the Proechidna with more than three claws.

The *lumbricales* are four in number arising from the great pad of the *profundus* tendon; the two muscles of the first pair pass distally to the fascia surrounding metacarpals 2 and 3 respectively, those of the second pair pass in like manner to the approximated sides of metacarpals 3 and 4. The two middle muscles of these four are practically fused into a single mass.

From the dorsal (carpal) side of the pad of the *profundus* arise three other small and flattened muscles:— the first originates between the tendons to digits 2 and 3 and passes to the fascia between those digits; the second takes origin from between the tendons to digits 3 and 4 and in like manner passes to the fascia between them; the third muscle arises slightly external to the base of the tendon of digit 4, and goes to the fascia between digits 4 and 5.

There are in addition seven other small muscles in the deeper portion of the hand. Three of these arise from the tendinous insertion of the *flexor carpi radialis*, the most external of which passes to the end of the first digit on the radial side. It is very probably the homologue of the *adductor pollicis* (Plate 1, fig. 3, *ap*) and is present likewise in Echidna. The two other small muscles pass one to the radial and one to the ulnar side of the second digit and insert on its first phalanx. In a similar fashion, two other small muscles

arise at the base of the third metacarpal and pass one to its radial and one to its ulnar side, inserting on the first phalanx. From a similar origin in the fascia covering the carpals at the base of the fourth metacarpal a small muscle passes to the investing tissue on the radial side of metacarpal 4, but there is no corresponding muscle on the ulnar side, unless, as seems quite probable, this is represented by a small muscle passing to the radial side of the *fifth* digit, that takes origin from a cartilaginous pad running from the pisiform bone to the base of digit 4. These five small muscles are doubtless to be considered the *interossei* (Plate 1, fig. 3).

A seventh small muscle arises just distal to the pisiform bone in the anterior prolongation of the tendon of *flexor carpi ulnaris*, and passes to the radial side of digit 5, into the terminal phalanx of which it inserts. This muscle seems to correspond to an *abductor digiti quinti* (Plate 1, fig. 3, *ab*). This last muscle apparently is not present in the Echidna, as it was not found by Mivart, Fewkes, or Westling. It is possible that it has been retained in the Proechidna to counterbalance the loss of the tendon from the *profundus*, as otherwise the fifth digit would be unprovided with a special flexor. The interossei of the Proechidna seem to be essentially as in the Echidna.

Muscles of the hind leg.— Concerning the homology of the *glutei* (Plate 1, fig. 1, *gm*, *gme*) in the Echidna, there has been more or less disagreement, and their relations in the Proechidna are quite similar. That portion of the *panniculus* muscle from the spines of the coccygeal vertebrae to the fascia investing the tibia (named by Fewkes the *dermo-flexor cruris*) was considered by Mivart a *gluteus maximus*. This muscle is also present in the Proechidna, as well as a second muscle just anterior, whose counterpart is found in the Echidna. In the former animal this second muscle is a broad sheet arising by thin aponeurosis from the third and fourth sacral and first caudal vertebrae. It tapers to an insertion by a flat tendon at the middle of the femur along the distal end of the trochanteric ridge. This muscle Mivart is inclined to consider a *gluteus medius* and Westling follows this determination. Fewkes doubts Mivart's interpretation, and would call this muscle a *gluteus maximus*, at the same time giving a new name to the superficial muscle to which Mivart had assigned the term *maximus*. From its origin and insertion there can be but little doubt that Fewkes is correct, but it is further probable that the cutaneous muscle (*dermo-flexor cruris*) may be a derivative of the *gluteus maximus*, as indeed Mivart suggested. The two divisions therefore would be analogous to the cutaneous and brachial portions of the *latissimus dorsi*.

What is clearly the *gluteus medius* (Plate 1, fig. 1, *gme*) is present in much the usual relations. It is a large muscle-mass arising from the lateral face of the ilium, and from fascia connecting the spines of the last lumbar and first two sacral vertebrae. It inserts on the head of the femur from the great trochanter to the acetabulum. What seems also to be a division of this muscle arises from the lateral part of the tuberosity of the ilium and passes as a rather easily separable bundle to an insertion about 10 mm. long at the proximal end of the trochanteric ridge. The muscle here considered the *gluteus medius*, Mivart and Westling have taken to be the *minimus*, since they assigned to the *medius* the crural division of the *maximus*. The *minimus* is, however, wanting as a distinct muscle in both the Echidna and the Proechidna.

The *pyriformis* (Plate 1, fig. 1, *py*) seems to be represented by a small muscle from the tips of the transverse processes of the fourth sacral and first caudal vertebrae. It passes over the posterior tuberosity of the femoral head and inserts on the lateral side of the trochanteric ridge at slightly less than half its length, just caudal to the insertion of the *gluteus maximus*. Between the latter and the *pyriformis* issues the sciatic nerve. Mivart found a similar muscle in the Echidna arising from five caudal vertebrae, but Westling failed to find it. Mivart notes that the nerve is superficial to the muscle instead of beneath it as usually.

The *capsularis* shows the usual relations. It arises as a thin sheet from the ilium between the acetabulum and the origin of *rectus femoris* and spreads out to an insertion about 10 mm. long at the proximal portion of the trochanteric ridge.

The *quadratus femoris* is a large muscle from a triangular origin extending from the tuberosity of the ischium to the acetabulum. It is inserted by tendinous fibers on the great trochanter just distal to the insertion of the *gluteus medius* and for about 10 mm. along the trochanteric ridge. Mivart speaks of this as a "delicate" muscle in the Echidna.

The *obturator externus* appears to be much as in the Echidna. It is large, of a triangular outline, and lies as usual underneath the *adductor femoris*. It originates from the anterior edge of the pubis at the base of the epipubic bones, and thence along the entire pubic symphysis and for about 15 mm. on the ramus of the ischium. At the most anterior portion the origin extends from the pubic border to the lip of the obturator foramen, but elsewhere it is from the outer edge of the pubis and ischium, whence it tapers slightly to the insertion in the entire intertrochanteric fossa.

The *obturator internus* is wanting as in the Echidna.

The *iliopsoas* is a large mass from two heads:—(1) the *iliac* portion which arises from the ventral side of the ilium from its tuberosity nearly half way to the acetabular notch; (2) the *psoas* portion from the three last lumbar vertebrae. The common insertion is by muscular and tendinous fibers into the lesser trochanter for about one half the distance between the lesser trochanteric head and the distal epiphysis of the femur. In the Echidna the *psoas* portion has origin from the three last lumbars and first sacral, but in the Proechidna the origin seems to be from the lumbars only.

The *psoas minor* arises from three heads, one each from the two last dorsal and the first lumbar vertebrae. The most anterior of these heads extends laterally on to the proximal end of the rib. The muscle narrows to a powerful tendon that inserts as usual on the anterior edge of the pubis directly in front of the acetabulum. In the Echidna the origin is slightly different, according to Mivart, "from the last three ribs, and....the bodies of the last three dorsal vertebrae." This difference may be correlated with the presence of an additional lumbar in the Proechidna.

The *biceps femoris* (Plate 1, fig. 1, *bf*) as in the Echidna, arises from a single head, by stout tendon from the lateral portion of the ischial tuberosity. It forms a flat sheet of muscle, triangular in outline and is broadly inserted along the lateral margin of the proximal three fourths of the tibia into the sheet of fascia investing the lower leg, and by a thin tendinous sheet continuous with this, into the lateral margin of the patella.

The *semitendinosus* (Plate 2, fig. 4, *st*) is from the lateral edge of the ischial tuberosity, a broad flattened band, inserting by muscular and tendinous fibers on the medial border of the tibia underneath the insertion of the *gracilis*.

The *semimembranosus* (Plate 2, fig. 4, *sm*) is a somewhat similar broad muscle, arising by tendinous fibers directly underneath the origin of the *semitendinosus*, on the tuberosity of the ischium. It inserts by a stout tendon on the medial surface of the head of the tibia.

The *sartorius* (Plate 2, fig. 4, *sa*) takes origin as a flat thin band for about 10 mm. along the anterior edge of the pubis just dorsal to the epipubic bone. It passes to the fascia investing the knee at the medial border of the distal head of the femur and the proximal head of the tibia.

The *gracilis* (Plate 2, fig. 4, *g*) muscles of opposite sides are separate medially. Each arises as a broad flat muscle from the basal one sixth of the epipubic bone, the entire pubic symphysis, and for a short distance on the ramus of the ischium. It inserts on the medial face of the tibia at the beginning of its second fourth.

The *adductor femoris* (Plate 2, fig. 4, *af*) has the usual two heads, *magnus* and *brevis*. The former arises along the caudal margin of the ischium, in part covered by the *semimembranosus*, from the tuberosity for slightly more than half the distance to the posterior end of the symphysis pubis. It inserts partly along the medial and posterior side of the distal end of the shaft of the femur, and in part by tendon in common with the *brevis* division on the medial epicondyle of the femur under cover of the *sartorius*. The *brevis* division arises along the symphysis pubis under cover of the *gracilis*. Its insertion is in part by the common tendon and thence proximally on the middle third of the femur.

The *adductor longus* (Plate 2, fig. 4, *al*) is wanting in the Echidna, but in the Proechidna seems to be represented by a short compressed muscle arising from the external base of the epipubis. It is inserted along the medial edge of the distal third of the femur in close association with the *pectineus*.

The *pectineus* (Plate 2, fig. 4, *pec*) is a somewhat similar muscle arising just dorsal to the *adductor longus*, on the anterior edge of the pubis. Its insertion is in close approximation with that of the latter, on the medial edge of the femur, but is slightly shorter.

The *rectus femoris* (Plate 2, fig. 4, *rf*) is from the ilium just anterior to the acetabulum and passes to its insertion into the proximal border of the patella and the fascia ensheathing the knee.

The *vastus lateralis* arises by muscular fibers from the whole anterolateral side of the femur from the median line to the trochanteric ridge. It inserts upon the lateral edge of the patella and becomes fused distally with the *rectus femoris* and *vastus medialis*.

The *vastus medialis* (Plate 2, fig. 4, *va*) is slightly smaller than the *lateralis*, and takes origin from the anteromedial portion of the shaft of the femur. It is partly fused with the two preceding muscles distally and inserts also on the medial side of the patella. A *vastus intermedius* is not to be distinguished in either the Proechidna or the Echidna.

The muscles of the lower leg are weak and slender. The *gastrocnemius* (Plate 2, fig. 4, *gas*) has much the same relations as in the Echidna. There is but a single head, from the ventral side of the medial tubercle of the femur, a flat narrow muscle that passes into a flat tendon on the lower half of the leg, and is inserted into the calcaneum at its external border.

The *soleus* (Plate 2, fig. 4, *so*) is a similarly shaped muscle, arising from the external side of the ascending proximal end of the fibula. Its tendon becomes bound by connective tissue to that of the *gastrocnemius*, and the two pass side

by side to the tarsus, where the *soleus* tendon passes underneath that of the latter to insert on the calcaneum.

Just medial of the origin of the *solcus*, at the tip of the fibular process arises a short flat muscle which passing into a long tendon, crosses under the *gastrocnemius* to the medial side of the leg, and passing through the groove between the distal head of the tibia and the naviculare, inserts at the base of the terminal phalanx of the first digit. It is also connected with the general fascia of the sole of the foot. This muscle is present in a similar relation in the Echidna, and is considered the homologue of the *plantaris* (Plate 2, fig. 4, *pla*) by Mivart and by Westling, an interpretation which is probably correct notwithstanding that there is no femoral origin, and that the insertion (at least in the Proechidna) is definitely into digit 1.

The *poplitcus* does not originate from the femur but from fascia between it and the long proximal extension of the fibula, and mainly by muscular fibers from the medial surface of this part of the fibula itself. It passes as a thick triangular muscle to an insertion on the medial edge and ventral part of the tibia for a centimeter or more at the proximal end. The same conditions obtain in the Echidna.

Partly underneath the origin of the *soleus* and extending slightly external to it on the head of the fibula arises the chief flexor of the foot, which appears to correspond to the *flexor longus digitorum* (Plate 2, fig. 4, *fld*). The origin is by tendinous fibers from slightly more than the proximal half of the postero-external aspect of the fibula. At the tarsus it becomes a stout tendon that inserts upon the internal edge of the calcaneum and then spreads out in the broad plantar fascia of the foot. Its four main tendons go to digits 1, 2, 3, and 4 respectively, inserting into the terminal phalanx. A fifth tendon comes off from the plantar pad between the tendons to the first and second digits and passes to the basal phalanx of the second digit on the external side. A similar tendon comes from between those to the second and third digits, and inserts on the basal phalanx of the third digit, making thus six tendons from the plantar pad. There appears to be no branch to the fifth digit.

Wedged in between the heads of the *soleus* and the *plantaris* and covered by them is a very small compressed muscle arising from the lateral margin of the proximal end of the fibula. At about half way on the length of the tibia it becomes a small tendon that joins the ental margin of the great tendon of the *flexor longus digitorum*, just proximal to the tarsus. This tendon is not traceable farther as it is fused with that of the latter muscle. This muscle

probably represents the *flexor longus hallucis*, and possibly gives rise to some of the small tendons described in connection with the *longus digitorum* as going to the bases of digits 2 and 3.

In the Echidna, the condition described for the flexors is quite different. There are five tendons described by Mivart, from the *flexor longus digitorum*, one to each of the five phalanges, and no *flexor longus hallucis*. Westling and Cunningham, however, found but four tendons from the *longus digitorum*, one each to digits 1 to 4. The small *longus hallucis* was not found in the Echidna by Mivart or Westling, nor does either mention the two additional small tendons from the plantar pad to digits 2 and 3, that are present in the Proechidna, apparently as parts of the *flexor longus hallucis*.

Three small muscles representing the *lumbricales* arise from the inferior side of the plantar pad and pass to the bases of the second to fourth digits respectively as small tendons. On the dorsal side of the plantar pad three other small muscles arise and pass to the third, fourth, and fifth digits respectively, on their external sides.

The *tibialis posterior* is a large muscle, nearly the size of the *flexor longus digitorum*. It arises from the proximal three fifths of the lateral and posterior sides of the fibula and from aponeurosis between tibia and fibula. It is covered in part by the heads of the *soleus*, *plantaris*, and *flexor longus*, and passes to a stout tendon running in the groove between the tibia and fibula just medial to the spur, and inserts into the proximal end of the astragalus. The condition in the Echidna is quite the same.

The *peroneus longus* (Plate 1, fig. 1, *pl*) is the most lateral of the lower leg muscles. It originates on the external side of the head of the fibula for about 15 mm. beginning just below the tip of the proximal extension. It tapers to a stout flat tendon as it reaches the end of the shaft, passes over the epiphysis of the fibula, and thence through the groove on the peroneal tubercle of the calcaneum, after which it goes to the ventral side of the foot to its insertion on the proximal edge of the fifth metatarsal; a small branch from the inserting tendon crosses the foot to the basal phalanx of the first digit. In the Echidna the condition seems to be much the same, although neither Mivart not Westling mentions the insertion of the tendon into the fifth metatarsal, which is a prominent feature in the Proechidna.

The remaining *extensores* of the hind foot are essentially the same as in the Echidna although apparently differing in a few slight details. The homology of these muscles is not altogether certain.

Next internal to the muscle last described arises what is doubtless the *extensor longus digitorum* (Plate 1, fig. 1, *el*). Its origin is from a flat broad tendon from the outer epicondyle of the femur, between the ascending process of the fibula and the patella. It passes to the inner tubercle of the fibula on which it is inserted and thence into a large flattish muscle that arises from the proximal half or more of the fibula, and (medially) from the interosseous fibers between tibia and fibula. This muscle is easily divisible into three parts: — the most external comes off superficially from the main muscular mass at 20 mm. below the head of the fibula and continues as a small spindle-shaped muscle to the distal head of the fibula where it passes into a delicate tendon that inserts as a thin sheet at the base of the fifth digit. In the Echidna Mivart found this branch inserting on the fourth digit of the *left* leg, but on the fifth digit of the *right* leg. He considers it a part of the *flexor longus digitorum*. Westling also in the Echidna, found a similar branch, whose tendon, however, became divided into two, the outer to the fifth, the inner to the fourth digit. This author considers the outer branch the equivalent of the *peroneus brevis*, and names the muscle *extensor digitorum IV et V*. From the condition in the Proechidna, however, it seems better to consider this muscle as representing a branch to the fifth digit from the *extensor longus digitorum* that, on acount of the reduction of the fifth digit, is in process of becoming quite separated. The branch to the fourth digit noted by Westling may be due to an imperfect separation of the fourth digit's tendon, since the small muscle is very closely appressed against the edge of the *extensor longus*.

The main portion of the *extensor longus* is radially compressed, but becomes flattened as it passes through the groove between the distal heads of tibia and fibula. On the tarsus it spreads out as a thin sheet of fascia to the bases of digits 2, 3, and 4. This sheet is continuous at the bases of the phalanges with the tendon to the fifth digit above noted.

Closely approximated against the medial border of this main portion, is another muscle nearly as large proximally, but passing at the distal epiphysis into a broad flat tendon. At the metatarsals this tendon becomes dorsal to that of the main tendon of the *longus digitorum* and goes to the bases of the second (mainly) and third phalanges. In the Echidna, the same condition was found by Westling, who names the muscle *extensor digiti II*. Mivart noted only the main insertion, that on the second digit, and considers the muscle equivalent to the *extensor longus hallucis*, even though it has no connection with the hallux. It is possibly a derivative of the *extensor longus digitorum*.

There remain two additional *extensors* at the tibial side of the leg. The more external arises by muscular fibers from between the heads of tibia and fibula, from the interosseous ligament, and mainly from the proximal two thirds of the shaft of the tibia. At the tarsus it becomes a flat tendon passing to the external side of the first digit. Closely applied to this muscle and practically united with it at the origin along the anterior side of the tibia, is a second and broader muscle likewise passing to a tendon that inserts beside the first on the dorsal surface of the hallux. Mivart, who regards both these muscles in the Echidna as parts of the *tibialis anterior* states that the internal tendon passes beneath the external at the insertion, but this is not true in the Proechidna. Probably Westling is correct in considering the more internal of these two muscles the *tibialis anterior* (Plate 1, fig. 1, *ta*) and the more external the *extensor longus hallucis*.

From the foregoing account it is evident that the musculature of the Proechidna is in the main similar to that of the Echidna. The chief points of difference are the following:— the supplementary portion of the *latissimus* arising in the Echidna from the vertebral angle of the scapula, originates instead from the ridge just dorsal to the glenoid cavity, and here sends out a second branch to the olecranon; the *serratus magnus* arises from the four most anterior ribs in the Proechidna, whereas in the Echidna the five anterior ribs are involved; the *rectus capitis lateralis* is from the axis in the Proechidna instead of from the atlas; a single median muscle, apparently a *sternohyoideus* is present, but seems to be lacking in the Echidna; the origin of the *caput longum* of the triceps is short, from the ridge on the scapula just dorsal to the glenoid cavity, whereas in the Echidna the origin extends nearly to the vertebral edge of the scapula; the *flexor profundus digitorum* in the Proechidna sends tendons to digits 2, 3, and 4 only, instead of to all five digits of the hand as in the Echidna; this difference, correlated with the reduction of the clawed digits to three in the former, seems of considerable importance, since the functional loss of digits 1 and 5 is correlated with the disappearance of their respective flexors; in the manus of the Proechidna a muscle apparently representing the *abductor digiti quinti* is present, but seems to be absent in the Echidna; an *adductor longus* of the hind leg seems to be wanting in the latter but is present in the Proechidna; there is also present in the hind leg a small muscle probably representing a *flexor longus hallucis*, whose tendon becomes fused with that of the *flexor longus digitorum;* this muscle is not present in the Echidna.

VISCERAL ANATOMY.

Digestive tract.— As long ago as 1877, Paul Gervais pointed out that the *tongue* of the Proechidna was much more highly developed than that of the Echidna, in correlation with the greater development of the beak. Its length he gave as 270 mm., while that of the Echidna was but 85. The horny papillae at its base are differently disposed, and its anterior portion which is trough-like is provided with three longitudinal series of spines, one median and two marginal, whereas the tongue of Echidna is smooth save at its base. The tongue of an adult Proechidna in the material studied, is 290 mm. long, of which the three rows of horny points, backwardly directed, occupy the terminal 80 mm. Of these points there are about 20 in the median and 22 in each of the lateral rows. The portion of the tongue bearing these points is flattened, with the margins slightly inrolled. Back from this tip, it is cylindrical and increases to a diameter at its base of nearly 14 mm. There is a patch of scattered horny papillae, backwardly directed, at the very base of the tongue. The tongue of a young individual is but 85 mm. in length and there are only 15 horny papillae discernible in each row at the tip of the tongue.

This young individual shows a series of *palatal papillae* in the midline of the rostrum. These are likewise directed backward, and the largest measure about 2 mm. in length. The first eight are each divided by a median furrow into a right and a left half. In the first six of these each half is secondarily divided into three minute lobes, one anterior and two posterior, but in the two following, the two posterior points are reduced to one. Farther back, the ninth to twelfth are single median papillae, and decrease regularly in size till the last two are almost imperceptible except as small rounded prominences, the last about opposite the middle of the orbit. At the posterior end of the palate are three transverse rows of horny, tooth-like papillae, the first of seven, the second of ten, the third of nine. These rows are about 4 mm. apart. In an adult specimen Gervais (1877–'78) describes five rows of these processes.

I can add nothing to what has previously been published on the *salivary glands* of the Proechidna. Viallanes (1879, 1880) has described the large elongate and flattened submaxillary glands which are very conspicuous in both the Echidna and the Proechidna. The terminal portion of the duct of these glands is larger in the latter, and reaches from the base of the tongue to the symphysis of the lower jaw. It expands into a fusiform reservoir with very glandular

walls, and from the internal face of this reservoir, as traced by injecting, pass four or five secondary canals that open directly on the floor of the mouth. In the Echidna there appears to be no such reservoir but the openings of the duct are more numerous, and lie in a single straight line from the base of the tongue to the symphysis. The same author describes a second part of the submaxillary gland in the Echidna, a superficial glandular mass, a little larger than the parotid, placed immediately under the skin, against the pectoral muscle. Its long duct runs forward to join that of the deeper submaxillary. I was unable to discover any trace of such a duct in the Proechidna. Viallanes also describes parotid glands in the Echidna rather far to the rear of the auditory conduit, and a sublingual gland in both Echidna and Proechidna that opens by a number of ducts into the floor of the mouth. The great development of the salivary glands in these and other ant-eating animals, as Tamandua, and the Golden-winged woodpecker, is doubtless an adaptation, perhaps for neutralizing the large amount of formic acid in the ants on which they feed.

The *stomach* of the specimen dissected is globular, about 70 mm. in transverse by 50 mm. in longitudinal diameter, with the oesophagus and pylorus only about 30 mm. apart. The small intestine measured about 2,450 mm., the large intestine about 480. The caecum (Plate 2, fig. 5) is short and with a rounded compressed tip. Its extreme length is 12 mm., its greatest diameter about 5.5. Its appearance seems almost identical with that of the Echidna.

The *liver* is large and rather thick. The left lateral lobe is rounded and simple, about 50 mm. in diameter and 20 thick. The right lateral lobe is of nearly the same size, but more elliptical in outline. Its cranial lobe is simple, thick, and rounded. Upon it lies the caudal portion which is of about two thirds its bulk and hollowed slightly at the posterior surface to receive the right kidney. The Spigelian lobe is stout and well developed, nearly an equilateral triangle in outline. The median lobe of the liver is the largest. Its cranial surface is undivided but its caudal surface is traversed by a deep furrow that divides it into a left median lobe and a cystic in which the gall bladder is superficially placed. This latter in the young specimen studied, is small and pyriform, about 20 mm. long by 12 in greatest diameter. In an adult animal it is more than twice these dimensions and of an elliptical outline, with the long axis at right angles to that of the body. The bile duct runs into the substance of the pancreas where it receives the short pancreatic duct about 2 cm. before it enters the small intestine at about the same distance from the pylorus.

The *pancreas* itself is flattened and oval, of rather firm consistency, and

lies in a loop of the small intestine. It measured 37 by 16 mm. in the young specimen examined. Its duct is short and as just noted, joins that from the gall bladder within the substance of the pancreas. Chapman (1887) in his account of the anatomy of the Echidna states that the pancreas has a separate duct in the specimen he studied and it enters the intestine at a point nearer the pylorus than does the bile duct. This, as he admits, is contrary to the usual condition, and must have been abnormal.

Mesenteries.— The duodenohepatic ligament is short, about 15 mm. long. About the same distance posteriorly is a short ligament binding the small intestine to the caudate lobe of the liver. The omental sac is largely developed, consisting of a thin and delicate mesentery with deposits of fat along the courses of the blood vessels. The large spleen is bound by it to the cardiac curvature of the stomach. The mesorectum and the mesocolon go forward to the anterior end of the large intestine, at which point the mesentery passes in a fan-shape to the entire length of the small intestine except for a short space, about 15 mm., at a point nearly thrice that distance back from the pylorus.

Spleen.— The *spleen* (Plate 2, fig. 6) is practically like that of the Echidna, proportionately large and of three distinct lobes:— a long narrow lobe, about 38 mm. long and 11 wide along the edge of the cardiac curve of the stomach, a similar but longer (80 mm. by 10) lobe on the greater or posterior curvature, and third, a lobe lying in the mesentery of the large intestine, narrow at first, but becoming terminally a large rounded mass, about 28 mm. in longest diameter and 19 mm. in transverse diameter.

Kidneys and genitalia.— The *kidneys* and *genitalia* seem to be quite as in the Echidna. The former are large and rounded, about 32 by 23 mm. in the specimen studied, and 18 mm. thick. The adrenal body lies just anterior to the hilum on the medial side of the kidney, is oval in outline, and measures about 14 by 7.5 mm. The ureters do not empty into the bladder directly, but run each to a point at its mouth just posterior to the opening of the vas deferens. The two ducts open here into the urethra by a common orifice provided with a small papilla. The testis is received into a slight hollow of the body-wall. The penis lies in the floor of the cloaca. As in the Echidna its gland is divided into four lobes. The cloaca is some 25 mm. long, and the large intestine enters well posterior to bladder, ureters, and vasa deferentia.

Lungs.— The *lungs* (Plate 2, fig. 7) seem rather small in proportion to the size of the animal. The right lung has two lobes. The larger extends the entire length of the pleural cavity and enfolds the smaller or ventral lobe so

that in ventral aspect, the latter appears to lie in a transverse depression of the large lobe. The left lung is simple, but has a slight cleft on the ventral margin anteriorly. A large azygos lobe lies transversely just posterior to the heart. Its shape is pyramidal, with a triangular cross section; its base lies near the middle of the right lung and it tapers to a point on the left side, where it is partly received into a depression of the ventral surface of the left lung. Apparently the condition is much the same in the Echidna, though Westling (1889) states that in this animal the right lung is three-lobed, the left single. Apparently the azygos lobe was included with the two lobes of the right lung.

PLEXUSES.

The plexuses of the Echidna have been studied and carefully figured by Westling (1889) and those of the Proechidna appear to differ but little. The brachial plexus is composed of the same nerve trunks in both animals. In the Proechidna, cervical nerves 7 and 8 unite almost at once to form a common trunk. The fifth and sixth cervicals are about equally large and unite with the combined seventh and eighth at about 17 mm. from the exit. Cervicals 3 and 4 are slightly smaller and the former unites with a very small second cervical before joining the other, chief trunk.

The lumbosacral plexus is formed by nerves from the last dorsal, the four lumbar, and two anterior sacral vertebrae. In the Echidna, Westling figures this plexus from an animal having 15 and another having 16 dorsal vertebrae. In the first, the plexus consisted of seven trunks, one from each of the last two dorsals, the three lumbars and two anterior sacrals; in the second it has an additional element from the antepenultimate dorsal, but in each case the first nerve to enter the complex was that of the 14th dorsal, indicating in the case of the specimen with but 15 dorsals that the 16th had been lost. Thus there is the same number of nerves in the plexus in both animals, notwithstanding that the Proechidna has an additional lumbar. The difference lies in the fact that only one dorsal enters the complex in the Proechidna. The fact that there are but two sacral nerves to enter the plexus in both the Echidna and the Proechidna lends weight to the contention of Gregory (1910, p. 152) that the number of true sacrals in both genera is two, and that the third or last sacral is really a modified caudal. On the other hand the three vertebrae usually considered sacrals have their transverse processes entirely united with the dorsal edge of the ilium and in this respect appear together to constitute the sacrum.

OSTEOLOGY.

In their original description of the Proechidna Peters and Doria (1876) figured the imperfect cranium on which they based the species. The adult skeleton was next described and well figured by Gervais (1877–'78) in the first part of his Ostéographie des monotrèmes. Dubois (1881) has figured the skull and the bones of the limbs, and in a later paper (1884) the elements of the sternum. He also gave brief notes on the skeleton. Thomas (1885, 1887, 1907, 1907a) has given cranial measurements of specimens in the British museum, and Weber (1888) has figured and described other adult skulls. The present discussion is confined to a summary of these notes together with such additional observations as I have been able to make on three other adult skeletons and the skulls of five younger specimens.

Skull.— The cranial sutures close early, and by the time that full size is attained, they have become nearly obliterated, although the other bones of the body are still incompletely ossified. Adult crania are therefore practically solid like those of birds, except that the ring-like tympanic bones remain separate from the rest of the skull. The seven crania in the collection of the Museum of Comparative Zoölogy represent several stages in this progressive ossification from that in which nearly all the sutures are evident, to that in which all have disappeared. The homology of the several bones, owing to the difficulty of obtaining specimens young enough to show the sutures, is still somewhat unsettled. Sixta (1900) endeavored to homologize the cranial elements of the adult Echidna with those of certain reptiles but van Bemmelen (1900) showed that this was only possible after a study of young skulls. The latter author and Lubosch (1906) have written on the monotreme skull and appear to have elucidated the main points. Our Proechidna material, however, seems to throw additional light on a few doubtful questions, and presents other details of value.

The occipital and parietal regions of the brain-case are most developed, a condition which Gregory (1910) notes as primitive among mammals. The exoccipitals are large; the dorsal and lateral margins of each are nearly at right angles where they meet dorsal to the condyles. The large supraoccipital slightly exceeds in breadth the combined width of the exoccipitals, with which it forms the posterior face of the skull. There is considerable variation in the degree to which these three bones share in forming the superior margin of the

foramen magnum. In one specimen (M. C. Z. 12,415) the exoccipitals meet in the median line and wholly exclude the supraoccipital from the foramen. In a second immature skull (M. C. Z. 7,398) this bone is likewise wholly dorsal to the exoccipitals, but the latter do not quite meet in the median line so that a deep and narrow emargination is left between them, extending dorsally from the foramen magnum to the median edge of the supraoccipital. In an adult skull belonging to the United States national museum, a similar condition seems to exist, for there is a narrow rounded emargination of the foramen at its median dorsal border. Although all sutures are obliterated, there can be no doubt that this emargination is due to the failure of the exoccipitals to meet ventral to the supraoccipital. In a fourth specimen (M. C. Z. 7,010) the last-named bone does reach the foramen magnum and forms its dorsal border between the exoccipitals, for a space of about 3.7 mm. Like variations are recorded by Weber (1904) in this animal and similar conditions occur in the skull of the Echidna. At one time these differences were even regarded as of taxonomic value.

Abutting against the entire anterodorsal edge of the supraoccipital and extending forward nearly to the nasal region is a large median bone which is generally considered the homologue of the interparietal. It covers the greater portion of the dorsal part of the head and extends laterally nearly or quite to the dorsal margin of the large bone forming the posterior part of the zygomatic arch. It seems to be an unpaired bone, although cranium M. C. Z. 7,010 shows a trace of a small suture-like mark posteromedially.

The frontals are rather small anteriorly and expand laterally to form the dorsal two thirds or more of the orbit. Between them, posteromedially, there appears in at least two specimens (M. C. Z., 7,009, 7,010) a small separate bone, of nearly oval outline. A similar bone seems to have been discovered by van Bemmelen in the Echidna "als selbstständiger Knochenkern in vorderen Theil der sogenannten Parietalplatte des Primordialcranium." I have found what seems to be a homologous bone in a number of specimens of immature gophers (Geomys). Its presence is due perhaps to some irregularities of ossification. In the Proechidna it fills a small space left where the frontals and the anterior emargination of the interparietal fail to come together. For lack of a better name I have called it an interfrontal. This bone is quite different from the so-called postfrontals of Sixta and Lubosch. The latter lie one at each side of the large interparietal directly posterior to the frontals, and help to form part of the lateral wall of the cranium. At their posterodorsal angle they meet

the lateral angle of the supraoccipital. There can be little doubt that these represent the parietals of other mammals, which through the extraordinary development of the median interparietal, have here become forced apart and occupy an inferior and lateral position.

In the Echidna and especially in the Proechidna the parietal is nearly covered underneath a large vertical expansion of the posterior end of the zygomatic arch. This (Plate 2, fig. 8, *j*) is a flat scale-like bone, prolonged anteriorly into a pointed process that articulates with the dorsal surface of a long narrow extension of the maxilla to form the zygomatic arch. Its posterior expansion is nearly semicircular in outline and dorsally may be in contact with the lateral edge of the interparietal. Ventrally it is extended slightly, at right angles to its lateral face, and lines the glenoid fossa for the articulation of the jaw. At its posterolateral edge it has an emargination where the external carotid enters, and passes forward to the orbit through a canal which thus runs between this scale-like expansion and the underlying bony wall of the cranium. This is the "temporal canal," considered a unique feature in mammals and doubtfully homologous "with a similarly placed canal in Anomodonts" (Gregory, 1910). This flat scale-like bone, perhaps as much from its shape as its position, is generally considered a squamosal. In immature skulls it is easily removed exposing the underlying parietal and a second bone that occupies the wall of the cranium between the parietal and the lateral margin of the exoccipital, a bone considered by van Bemmelen the "mastoid." If this flat scale-like bone be interpreted as a squamosal, it becomes necessary to conclude (1) that the jugal is quite wanting and (2) that the so-called "squamosal" does not form part of the brain-case, as can be shown in young specimens only. The first character is highly aberrant and the second apparently unique among mammals. Van Bemmelen endeavors to overcome the second difficulty by considering the bone underlying the supposed squamosal, as a greatly developed mastoid portion of the periotic. It seems, however, that another and simpler interpretation is possible. Had van Bemmelen been able to flake off this "squamosal," he would have found that the "mastoid" extended forward from the exoccipital to the posterior margin of the parietal. At its ventrolateral border it becomes hollowed underneath the articulating surface of the glenoid cavity formed by the extension of the "squamosal." The so-called "mastoid" bone, in short, seems to fulfil all the requirements of a true squamosal and fuses ventrally with a mastoid portion that lies on the ventral wall of the brain-case lateral to the basioccipital.

If this interpretation be allowed, it is evident that the so-called "squamosal" is a greatly expanded jugal that has become flattened and appressed against the wall of the brain-case so as to obliterate almost completely the temporal fossa, of which the temporal canal for the passage of the external carotid is the only vestige. In Ornithorhynchus the posterior portion only of the jugal is applied to the brain-case so that the canal is very short and the orbitotemporal fossa nearly open. Further evidence is afforded by the muscles, for the temporalis, which inserts usually on the jugal, is inserted on the zygomatic portion of this bone, and the digastric, which usually originates anteriorly from the mastoid region, is in living monotremes found arising from what is here considered the true mastoid or squamosomastoid, not from what van Bemmelen considers the squamosal. Against this hypothesis is the belief of van Bemmelen that the process on the anterior dorsal edge of the arch in Ornithorhynchus is a true processus frontalis, and he further adds that in a young skull he found this process separated by a slight suture from the processus jugalis squamosi. In a second young skull, however, he found no such condition. It seems eminently probable that this process in Ornithorhynchus is not the homologue of the frontal process in higher mammals, but a dorsal extension of the maxillary portion of the zygoma. Perhaps a more serious objection to the above interpretation is that the glenoid cavity is entirely lined by an inward extension of the jugal. That the jugal should share in the formation of the articulating surface, however, need prove no difficulty, for such a condition obtains, though in much less degree, among the Marsupialia. Thus in the Giant kangaroo (*Macropus giganteus*) the posterior extension of the well-developed jugal lies against the ventral border of the squamosal process and actually forms part of the articulating surface for the broad condyle of the jaw. In other marsupials (*e. g.* Didelphys) this extension merely reaches the glenoid cavity and forms its lateral boundary. It is not difficult to conceive of its extension to cover the floor of this cavity as it appears to do in Proechidna. Moreover, Gaupp (1908) has figured this bone in a partial reconstruction of the primordial cranium in the embryo Echidna, and at this stage apparently, there is no inward extension to the glenoid cavity; the bone seems too far anterior to the mastoid region to fulfil the requirements of a squamosal. It is further of interest to note the tendency to a posterior dorsal expansion of the jugal in certain other marsupials so that with the ventral extension a V is formed into which the squamosal process fits. This dorsal arm is probably the homologue of the broad scale-like expansion which in the Proechidna covers the lateral wall of the brain-case,

and in Ornithorhynchus forms the narrow bridge across the temporal canal. What seems to be an analogous condition is found in certain other groups, as in the Cervidae, the Bovidae, and such Carnivora as Mungos (= Herpestes) in which the frontal process is largely developed at the posterior end and by fusion with the postorbital process makes a complete bony orbit and separates the temporal fossa posteriorly. The temporal canal in existing monotremes is thus the temporal fossa greatly restricted by the scale-like expansion of the posterior part of the jugal. In the Echidna this expansion is divided dorsally by a rather deep notch into an anterior and a posterior lobe, the former of which overlies the ventral edge of the parietal. In the Proechidna, the notch is much less evident, the dorsal outline of the jugal more nearly hemispherical and the anterior end extends far enough forward to overlap the posterior corner of the frontal.

Except for differences in relative size and form the bones of the palatal and rostral regions are essentially similar in the Echidna and the Proechidna. The termination of the palatals is slightly different, however, in the two. In the former the medial portion of the palatal is produced posteriorly as a prominent spine beyond the union with the pterygoid and there is a deep narrow reëntrant between the two palatals. In the Proechidna one specimen shows a practically similar condition but in five other specimens the reëntrant is broad and shallow, and the palatals are rounded or truncated so as to merge with the posterior outline of the pterygoids.

The nasals in the Echidna do not extend posterior to the margin of the orbit, whereas in the Proechidna they extend back to a point nearly opposite the middle of the orbit. Since they overlap the frontals for nearly a centimeter at this point, the latter bones appear for an absolutely shorter distance on the dorsal aspect of the skull than in the Echidna. In both, the nasals taper distally to a median point at some distance behind the nasal aperture, so that this latter is bounded entirely by the premaxillaries which meet and unite dorsally. The exclusion of the nasals from forming part of the boundary of the nasal aperture is a singular and unique condition to which apparently no attention has hitherto been paid. It is probably a specialized development, in part an accompaniment of the elongation of the rostrum. In the Echidna the distance from the nasal aperture to the tip of the nasal bones is one fourth of the length of the nasals. In the Proechidna it is slightly more than half their length, thus indicating the relatively greater development of the rostrum in the latter animal. In other mammals in which the rostrum is greatly prolonged, for example the

Great anteater (Myrmecophaga), the nasals have kept pace with the growth of the snout and appear at the dorsal side of the nasal aperture. Apparently in Ornithorhynchus these bones are not thus excluded by the premaxillaries which in this animal form the sides and anterior boundary of the opening.

The series of skulls of the Proechidna shows certain features of interest in regard to the order in which the sutures close. In the youngest specimen (M. C. Z. 7,009) all the chief sutures are discernible with little difficulty, and the broad jugal bones are so slightly fused with the cranium that they came entirely away in cleaning. The sutures of the occipital portion of the skull are especially clear, and the small median interfrontal is distinctly outlined. In a second specimen (M. C. Z. 7,010) of practically the same size, the premaxillaries are thoroughly fused in the dorsal midline, from the tips of the nasals to the nasal aperture, and the nasals are fused along their median line of contact though still separate laterally from the surrounding bones. The interfrontal is also with great difficulty to be traced, and the anterior edge of the large interparietal is beginning to coalesce medially with the frontal. At the occipital region of the skull the condylar portion of the basioccipital has become fused with that of the exoccipital though elsewhere the occipital sutures are broadly open. The parietal sutures are disappearing and the jugal is merging into the cranial wall. The other sutures are still traceable. A third skull (M. C. Z. 12,415) has attained adult size and shows an advance in ossification. In dorsal aspect the only sutures visible are:— the lateral and dorsal sutures marking off the exoccipitals, the lateral suture bounding the supraoccipital, the suture between the jugal and the maxillary process of the zygomata, and the sutures delimiting the maxillaries from the frontals, nasals, and premaxillaries. The nasals are solidly fused together and to the premaxillaries, though these are still distinct laterally and ventrally from the maxillaries. Conspicuous roughened furrows are developed on the vertex of the cranium for the attachment of muscles, and the posterior expansions of the jugals are solidly fused with the skull. In ventral aspect, the posterolateral boundaries of the basioccipital are quite obliterated but elsewhere the sutures delimiting this bone are still open, so that in appearance the basi- and exoccipitals are fused into a single bone whose boundaries are everywhere distinct. The bones of the palatal area are still unfused, but those of the orbit have become well soldered together.

As in the Echidna the palatal branch of each premaxilla becomes much drawn out posteriorly and extends as a narrowly tapering process to the origin of the zygomatic portion of the maxilla. This bone seems to increase slightly

in length up to the time when the premaxillaries fuse dorsally, after which there is practically no change in its length. The continued elongation of the rostrum seems thereafter to take place by growth at its basal portion so that the termination of the premaxillary is carried progressively farther forward from the ventral margin of the orbit. This is in accord with the fact that the sutures at the base of the rostrum are the last to close in the dorsal view of the skull. Thus in a partly grown skull M. C. Z. 7,010, in which the premaxillaries have fused dorsally, their extreme ventral length is 73 mm., and from the posterior tip to the orbit is 12.5 mm. In the fully grown skull, M. C. Z. 12,415, in which these sutures are still visible, the extreme length of the premaxillary branch is 74 mm., practically as in M. C. Z. 7,010, but from its posterior tip to the orbit is 29 mm., indicating that later growth has been entirely at this basal portion of the rostrum. The premaxilla at the same time has been carried forward and a line is left in posterior continuation of the cleft into which its tip fits.

Cranial Measurements of the Proechidna.

	Type	12,415	12,414	22,992	7,010	7,398
Greatest length	—	172	178	182	143	146
Basal length	—	161	167	169	134	136
Palatal length (from posterior process)	—	145	152	156	120	122
Tip of rostrum to orbit ventrally	108	103	109	113	85	84
Least interorbital width	19	19	20	19	20	20
Greatest width of brain-case	56	55	55	55	54	52
Anterior margin of orbit to temporal canal	—	45.5	44.5	41	43	41.5
Greatest length of mandible	—	130	138	139	111	110

Two quite adult skulls have also been studied. These are of the size of M. C. Z. 12,415 but show a stage farther in ossification. The first (12,414) is in the collection of the Museum of Comparative Zoölogy; the second (22,992) is in the collection of the United States national museum. In both, the sutures are totally obliterated, and the crania are solid masses of bone, except that the tympanic rings (wanting in 22,992) have not fused with the rest of the skull. Rugosities are developed for muscle attachment on the vertex of the skull, and just back of the orbit a slight ridge or process is developed on the frontal which may be considered a postorbital process homologous with that of other mammals. A small swelling opposite it near the anterior end of the jugal defines the orbit, back of which the broad plate-like expansion of the jugal covers over nearly all of the temporal fossa. The rami of the lower jaw though

closely applied along the symphysis for some 40 mm., are not anchylosed, but doubtless remain separate throughout life. The measurements of three adult skulls and two smaller and more youthful examples, as well as those of the type as given by Peters and Doria (1876) are tabulated on page 296. Thomas (1888) gives dimensions of two skulls in the British museum.

Gervais (1877–'78) in his account of the osteology of this animal figures two skulls. The first is shown in his Plate 9, fig. 1, of natural size, and is of almost exactly the same dimensions as M. C. Z. 12,415 given above. No sutures are indicated and it is doubtless the skull of a nearly mature animal. Gervais considered it the skull of a male. In his Plate 7, figs. 1–1b, are shown three views of a larger skull, of natural size, which if correctly drawn, indicate a larger animal than either of the old examples here noticed. The greatest length of the skull, as measured from these figures is 197 mm.; basal length, 187; palatal length, 174±; tip of rostrum to orbit, 129; least interorbital width, 19; greatest width of brain-case, 57; anterior margin of orbit to temporal canal, 43; greatest length of mandible, 153.

The hyoid apparatus of the Proechidna appears to be still undescribed. The larynx is situated far posteriorly on the throat and the hyoid bones are few and small (Plate 2, fig. 7). The basihyal is relatively broad and bears at each end on its anterior face a cephalic cornu of two pieces, the basal of which probably represents a ceratohyal. The more distal piece is of about half the size of the latter and tapers to a point which is connected by tissue with the sides of the pharynx. No tympanohyal articulating the larynx with the skull appears to exist. At the posterior face of each end of the basihyal, a large thyrohyal passes dorsally to the cephalic cornu of the thyroid cartilage. The cricoid cartilage joins the thyroid by a common median cartilage, though a faint transverse line probably indicates the original separation of the portion proper to each ring. The more ventral portions of thyroid and cricoid are bony. The arytenoid processes are produced backward as a long tapering cartilage to the dorsal end of the cricoid. Following the cricoid is a large, nearly complete tracheal ring, succeeded by the trachea, which consists of some 18 or 19 cartilaginous pieces not quite complete dorsally.

Vertebrae.— The vertebrae of the Proechidna have been well figured by Gervais (1877–'78) and their general character is as in the Echidna. The first seven (cervicals) have a complete vertebral arch, formed by the union of the cervical rib with the transverse process and the centrum. In old individuals these ribs become solidly fused with their respective vertebrae. Such true

cervical ribs are regarded as primitive. The succeeding ribs are attached by their capitula only, since the tubercula are wanting and articulate by demi-facets with two contiguous vertebrae. An anomalous feature in monotremes is the perforation of the neural arches of the dorsal and succeeding vertebrae by their spinal nerves, which usually issue from between the vertebrae in other mammals. According to Gregory (1910) this seems to be a unique feature.

The vertebral formula for the Proechidna is given by Gervais (1877–'78) as:—C 7, D 17, L 4, S 3, Ca 12 = 43 which is thus one dorsal and one lumbar more than ordinarily assigned to the Echidna. This is the vertebral formula commonly ascribed to the Proechidna, and the additional vertebrae are considered as forming an important generic character. No new observations as to the vertebral formula have been published except that Dubois (1884) in urging that 17 instead of 16 pairs of ribs may be considered one of the generic characters, adds that a skeleton examined and briefly described by him had but 16 pairs. Two of the specimens in the collection of the Museum of Comparative Zoology are accompanied by nearly complete skeletons, both of which were carefully cleaned by the writer; in addition the mounted skeleton belonging to the United States national museum has been studied. From these various sources, the following data are derived as to the vertebral formula:—

Gervais (1877–'78):	C 7, D 17, L 4, S 3, Ca 12 = 43
Dubois (1884):	C –, D 16, L –, S –, Ca — = —.
M. C. Z. 12,414:	C 7, D 16, L 4, S 3, Ca 12 = 42.
M. C. Z. 12,415:	C 7, D 16, L 4, S 3, Ca 11 = 41.
U. S. N. M. 22,992:	C 7, D 16, L 5, S 3, Ca 12 = 43.

As was perhaps to have been expected there is a slight amount of variation. The usual seven cervicals are present in all the cases known; but in the Echidna there is variation even here, for Broom (1900) has recorded a case in which eight cervicals were present. Four of the five specimens have 16 dorsals and the fifth has 17, so that the usual number may fairly be considered 16 as in the Echidna. An additional young specimen in the collection of the Museum of Comparative Zoölogy, has, however, but 15 pairs of ribs. The interpretation of the lumbar and sacral vertebrae appears to have offered some difficulty. In the Echidna these are generally considered to be three each. Gregory (1910, p. 152) writes:—"Howes (1885, p. 89) gives 4 sacrals to *Echidna* and 3 to *Ornithorhynchus*. In that case both genera would have 19 dorsolumbar vertebrae (*Proëchidna* 20) a number characteristic of primitive Marsupials." In Gregory's opinion, however, "the anterior 'sacral' is only a slightly modified lumbar and

the posterior sacral only a slightly modified caudal." He assigns to the Echidna the formula, C 7, D 16, L 5, S 2, —, Ca 10 = 40. In the skeletons of the Proechidna studied, there seems no reason to doubt that three is the number of functional sacral vertebrae in each, anterior to which in M. C. Z. 12,414 and 12,415 there are four undoubted lumbars. In M. C. Z. 12,414, an old individual, four vertebrae enter into the fused sacral mass, but the most posterior of these is very evidently a caudal that has become thoroughly united by its centrum and articular processes to the last sacral, and by its transverse processes to the posterodorsal margin of the ilium. It is therefore reckoned as a caudal. Evidence for the belief that the sacrum includes morphologically but two vertebrae is found in the fact that but two and these the anterior two sacral nerves enter into the lumbosacral plexus. Gervais considered four and three the numbers respectively of lumbars and sacrals in his specimen, so that these may be considered the normal number of each. In the skeleton belonging to the United States national museum, however, there are five lumbars in addition to the three sacrals, evidently an unusual condition. The caudals, as in the Echidna seem usually to be 12 in number, though one (M. C. Z. 12,415) had but 11. There are six chevron bones, the first of which comes between the third and fourth caudals. They are simply small oval ossicles, of which the second is the largest and from it the remaining four form a diminishing series. The usual vertebral formula for the Proechidna may therefore be considered as C 7, D 16, L 4, S 3, Ca 12 = 42, which differs from that of the Echidna in having four instead of usually three lumbars, although even this difference may disappear, since four lumbars are said to occur in the Echidna in certain instances. Thus McKay (1894) has tabulated the vertebrae of eighteen specimens of the Australian Echidna and shows that the range of variation is considerable, namely, cervicals 7, dorsals 14 to 17, lumbars 2 to 4, sacrals 3 to 4, caudals 10 to 12. It thus appears that no generic difference in vertebral formulae exists, as once supposed, between the Echidna and the Proechidna for the range of individual variation bridges over the gaps.

Ribs.— Six of the ribs articulate directly with the sternum as in the Echidna. The sternum in a nearly grown individual, consists of four rib-bearing portions. The first is the manubrium, broadly expanded at its anterior end, where the first pair of ribs meets it, and contracted posteriorly, where it is joined by the second pair. Dubois (1884) figures this first segment as ossifying in a youngish specimen of what he calls *P. villosissima* from two lateral centers. The three succeeding sternebra are slightly narrower than the posterior end of the manubrium.

The first and second support each a single pair of ribs, while the third supports the fifth and sixth pairs. This last piece thus evidently represents two sternebra fused, as indicated in addition, by a slight furrow on the sternebrum between the last two sternal ribs, marking the point of fusion. There are four remaining sternebra making nine in all, but these last are small and do not support ribs. In an old individual the five rib-bearing sternebra are reduced to three, owing to the complete fusion of the last three. Gervais's figures indicate similar conditions. The dorsal end of the sixth sternal rib is greatly expanded, and so likewise are the ventral segments of ribs 7 to 12, which overlap each the one next anterior. Ribs 13 and 14 have a cartilaginous connection only, with these bony plate-like portions, while ribs 15 and 16 are short, and backwardly directed, without particular connection with the thoracic basket.

Girdles and limbs.— The characters of the pelvic and pubic girdles are in general similar to those of the Echidna as ably discussed by Gregory (1910, p. 152–153). The various elements of each are in adults thoroughly fused, although the line of union of the scapula with the interclavicle usually remains distinct. In M. C. Z. 12,414, an old animal, the line of suture is still clear between the left coracoid and procoracoid.

There can be no doubt that the Proechidna with normally three claws on each foot is a derivative from some form which like the Echidna was five-clawed. In this and certain other respects, it therefore represents a stage in advance of the condition shown by the Echidna so that as Toldt (1905) justly says, the term Proechidna is somewhat of a misnomer. Several cases are on record in which more than three claws have been noted on the foot of the Proechidna, and these must undoubtedly be considered as instances of regressive variation. On both fore and hind feet it is digits 2, 3, and 4 that are normally provided with claws. Digits 1 and 5 are usually covered by a callosity and at most are mere prominences in external aspect. Of the eight specimens in the collection of the Museum of Comparative Zoölogy, two only show more than the normal three claws on each foot. The first is a mounted specimen, 6,722, from northern New Guinea, in which there is a claw on digit 5 measuring about 19 mm. in both right and left fore feet. I suspect that there were also claws on digit 5 of each hind foot, but these if present must have become lost. The chief reason for this belief is that they exist on the fifth digits of the fore and hind feet in the United States national museum's specimen 22,992 which is the skeleton of apparently the same individual whose mounted skin is in the Museum of Comparative Zoölogy. Both were purchased independently from Ward's Natural science estab-

lishment a number of years ago. The second anomalous specimen is M. C. Z. 7,009, collected by Dr. Thomas Barbour in Sorong, New Guinea. This specimen has the usual three claws on each of the fore feet, but a small extra claw on digit 5 of each of its hind feet. This extra claw measures 9 mm. in length. There are several other cases of variation on record, as follows:—

Thomas (1907*a*, p. 499, footnote) records that the type specimen of his *Acanthoglossus bruijnii bartoni* had five claws on both of the fore and hind feet, as in the Echidna. Weber (1888) describes at length a specimen in Amsterdam, that had five functional claws on both fore feet, and four on each hind foot. From his figure it is seen that the supernumerary claw on the hind foot is that of digit 5, though in the text, through error, it is given as of digit 1. Its length is 15 mm., or less than half that of the fourth claw. Toldt (1906) mentions two other abnormal specimens. The first of these is in the Museum at Brussels. On digit 1 of the right fore foot is a second phalanx bearing a claw 12 mm. long. The left fore foot, however, has but the usual three claws on digits 2, 3, 4, as have also the hind feet. The second individual is in the Umlauff museum at Hamburg. The left fore foot only of this individual is abnormal in that each of the five digits bears a claw. That of digit 1 is short and rounded but that of digit 5 is more fully developed, 11 mm. long and 6 mm. broad. The six known abnormally clawed individuals of this genus may be tabulated as follows, the numeral expressing the presence of a claw on its respective digit.

Abnormally clawed Proechidnas.

Specimen.	Right Fore.	Left Fore.	Right Hind.	Left Hind.
British Museum	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5
Amsterdam	1, 2, 3, 4, 5	1, 2, 3, 4, 5	0, 2, 3, 4, 5	0, 2, 3, 4, 5
U. S. N. M. 22,992	0, 2, 3, 4, 5	0, 2, 3, 4, 5	0, 2, 3, 4, 5	0, 2, 3, 4, 5
M. C. Z. 7,009	0, 2, 3, 4, 0	0, 2, 3, 4, 0	0, 2, 3, 4, 5	0, 2, 3, 4, 5
Brussels	1, 2, 3, 4, 0	0, 2, 3, 4, 0	0, 2, 3, 4, 0	0, 2, 3, 4, 0
Hamburg	0, 2, 3, 4, 0	1, 2, 3, 4, 5	0, 2, 3, 4, 0	0, 2, 3, 4, 0

Since some twenty-five or more specimens are recorded in which the claw formula for each foot is 0, 2, 3, 4, 0, this must be considered the normal condition, from which regressive variation sometimes takes place. In case of the hind feet, digit 1, as might be expected from its less marked skeletal development, is much more rarely clawed than is digit 5 — in fact there is but one recorded case of a claw on the first hind digit. No instance is known of its presence without also an accompanying claw on digit 5. No doubt the order of disappearance in phylogeny is first claw 1, then 5. The reduction of the fore

claws may have begun later phylogenetically, for except the British museum specimen having five claws on each foot, there is but a single case (M. C. Z. 7,009) in which the fore claws are less in number than the hind.

In normally clawed specimens, there are three phalanges in each of digits 2, 3, 4, but only two in digit 5, and one in digit 1. In the mounted skeleton belonging to the United States national museum, in which there is a claw on each digit 5, the latter has three phalanges, in each case. This extra phalanx is the terminal or claw-bearing one, and is doubtless the one that is lost in the normally clawed individuals. This is further indicated by Dubois (1881) who found in one example, three phalanges on each hind digit 5, and two on each hind digit 1. In every case the terminal extra phalanx was small, bore no claw, and evidently was a mere remnant of a once functional member.

Gervais figures a palmar sesamoid, such as is so well developed in certain edentates, but I found none in the specimen I dissected, which was probably too young.

The remaining bones of the feet and limbs are not essentially different from those of the Echidna, except that the humerus differs conspicuously in its distal outline. The internal tuberosity is broad and evenly rounded and has a comparatively shallow notch at the internal border of the articulating area. In the Echidna on the other hand, the inner tuberosity is narrower and with a deep notch in its distal margin below the entepicondylar foramen. The notch at the ental side of the articulating surface is also much deeper. It is in exactly these points that the fossil humerus of Owen's *Echidna ramsayi* (Owen, 1884, pl. 14) from New South Wales, Australia, agrees with the humerus of the Proechidna and differs from that of the Echidna. For this reason, as well as on account of its large size, I consider this extinct animal the representative of the genus Zaglossus in Australia. Although it has become extinct on that continent, it seems apparent that the genus in its restricted sense, formerly was represented there, and that through a land-bridge that has since disappeared, it reached New Guinea at the same time with the true Echidnas (*Tachyglossus lawesi*) and has there survived. With regard to the remains of this Australian Proechidna but little has been published. Krefft (1868) in a brief note, first announced the discovery of this extinct animal and figured the distal condyle of the humerus. He says that he does not wish to name it lest it may have been already described, but otherwise would call it *Echidna owenii*. Apparently this name must hold good for the species. Owen (1884) described and figured a nearly entire humerus, and later (1887) recorded that in the "Wellington bone

and breccia caves" of New South Wales, further portions had been discovered, including an entire humerus, a large portion of the skull, atlas, a tibia, and fragmentary evidences of other parts of the same skeleton." The edentulous condition, proportions, and conformation of the jaws, together with other "characteristic modifications of this monotrematous genus [Echidna], are repeated on the same magnified scale as in the mutilated arm-bone previously described and figured." The nature of these remains is not further indicated, but it seems probable that they are referable to the Proechidna, as, indeed, Flower and Lydekker (1891, p. 127) point out; they state that "In referring this species to the genus *Echidna*, that term must be regarded as including *Proechidna*." The fossil humerus as figured by Owen (1884) is but very little longer than that of an adult New Guinea Proechidna.

Spur.— Gervais found a spur on but one of his two specimens, the one by him regarded as a male. It is generally considered absent in the adult female as is true also of the Echidna and the Duckbill. Thus Toldt (1905) found no spur in one of the Vienna proechidnas he examined, while a second had a rudimentary one only. In two alcoholic specimens in the Museum of Comparative Zoölogy, that were males by dissection, the spur was well developed. It is slightly attached by connective tissue at the tarsus, but I was unable to discover any trace of a gland or duct in connection with it, such as is described for the Duckbill.

HABITS.

Practically nothing is known of the habits of the Proechidna in a wild state. According to A. A. Bruijn, by whom the original cranium was sent to Peters and Doria, the specimen was found by a native hunter on Mt. Arfak, at a considerable altitude. Here the animal was said to be not rare, living in burrows; the natives hunted them by the aid of dogs, and were fond of their flesh. The hairy coat was said to be long and very harsh. Gervais had two specimens from the Karon Mountains, northern New Guinea, at an altitude of 1,150 meters. The natives called it *nokdiak*. In British New Guinea, a specimen is recorded by Thomas (1907) from Mt. Victoria at an altitude of 8,000 feet, and is made the type of the race *bartoni*. Guillemard (1886) writes that his native hunters at Doreh Bay obtained a specimen for him, and that it was said to live in burrows in rocky ground. It is doubtless an inhabitant of rocky places, and therefore avoids the low country along the coast, but present evidence does not indicate that it is confined to high altitudes. Dr. Thomas Barbour in 1906

obtained two living Proechidnas from the natives at Sorong, a small low lying island which is separated by a shallow and narrow strait from the Papuan mainland. These were both captured by a party of Papuans who had been on an excursion to the hills which lie a few miles back from the swampy coastal plain bordering the mainland shore.

One of Dr. Barbour's specimens (both of which he has presented to the Museum of Comparative Zoölogy) was in good condition and he has kindly written the following account of it:—"This specimen was kept alive for about a month and a few observations on its habits were made. It was absolutely nocturnal and spent the day partially buried in the deep layer of sand which was kept in its cage. It slept rolled up with its snout turned directly under its chest and covered by the fore limbs. When aroused and taken out in daytime, it would lie flat on its stomach with its snout stretched out resting on the ground. If disturbed, it at once turned its snout under it and raised a heavy fold of skin that moved down over the forehead and protected it by carrying forward a heavy armament of spines. The subdermal musculature is remarkably strong and effective, causing the spines to be quickly turned and rigidly held in any direction. At night it moved about sluggishly, often digging with motions that strongly recalled those of a turtle. It fed on ants only, which were procured by placing in a dish a considerable amount of shredded cocoanut. The ants soon swarmed in this and the whole was then placed in the Proechidna's cage. It ate the insects by thrusting its long tongue down into the cocoanut. It took a little water or water with condensed milk, but seemed to drink very little."

Most of the specimens of Proechidna come from Dutch New Guinea—Mt. Arfak (type locality), Karon Mountains, Dorch Bay, Sorong, the hilly country between Fak Fak and McCluer Gulf; specimens are also recorded from the Finisterre Mountains of German New Guinea and from Mt. Victoria, British New Guinea. A specimen (*goodfellowi* Thomas) from the island of Salawatti, really a part of western Dutch New Guinea, is doubtless identical with the Proechidna of the mainland.

SUMMARY AND CONCLUSIONS.

The foregoing account is based on a larger series of skins accompanied by skulls than has ever before been brought together, while in addition four skeletons have been examined and dissection made of an alcoholic specimen.

From a comparison of these as well as from a careful study of the

descriptions of the five described forms or species of the Proechidna, the conclusion is reached that all are referable to a single living species, namely *Zaglossus bruijnii*, of New Guinea, and that the various nominal races are based on individual variations due to age, wear, albinism, or individual differences in pigmentation and molt.

On account of the size and conformation of the humerus figured for the extinct *Echidna owenii* of New South Wales, it seems that this animal should be referred to the genus Zaglossus, thus establishing the occurrence of both Zaglossus and Tachyglossus, the Proechidna and the Echidna, in Australia as well as in Papua.

The musculature is essentially like that of the Echidna, but that of the limbs shows important differences correlated with the reduction of the functional digits from five to three. Thus the *flexor profundus digitorum* sends tendons to digits 2, 3, and 4 only, and no trace is left of the additional tendons to 1 and 5 that are present in the Echidna with its five-clawed manus. There is also in the hand a muscle apparently representing the *abductor digiti quinti*, which seems to be absent in the Echidna. The *adductor longus* is present in the hind leg of the Proechidna but apparently is lacking in the Echidna, and a small muscle probably representing a *flexor longus hallucis* is also found, but is absent in the Echidna.

In correlation with the elongation of the beak, the tongue and salivary glands are more developed in the Proechidna. No second portion of the submaxillary gland was detected. There is a common duct by which the gall-bladder and the pancreas enter the intestine, not two separate ducts as described for the Echidna by Chapman.

The supposed differences in vertebral formulae between the Proechidna and the Echidna are shown to be unreliable. Both exhibit a considerable degree of individual variation. A study of the young skull reveals several interesting peculiarities, such as a small median bone formed posteriorly between the frontals and here called interfrontal. The nasals are shut off from the external narial opening by the meeting of the premaxillaries in front of them. The zygomatic arch is shown to be formed mainly by an enormously expanded jugal, and the squamosal, which has been supposed to form the arch is really covered by the jugal and forms part of the brain-case as usual. The temporal canal of existing monotremes is merely the remnant of the temporal fossa, largely closed over by the expansion of the jugal dorsally. A ventral expansion of the jugal lines the glenoid cavity of the jaw.

Although there are normally three functional digits on each foot, six cases are recorded in which there are more than this number. These are to be considered as regressive variations to the five-clawed condition as seen in the Echidna. Only one case is known in which there were five claws on each foot.

The validity of the genus Zaglossus for the Proechidna as distinct from Tachyglossus for the Echidna has been questioned, but as modern generic concepts go, they may well be kept apart. The chief characters of Zaglossus are: — (1) the great elongation and depression of the rostrum, with the accompanying greater development of the tongue and salivary glands; (2) the usual possession of but three functional claws on each foot, correlated with important differences in certain of the muscles of the fore and hind legs; (3) the outline of the distal end of the humerus is very different from that of the Echidna, with a broad, evenly rounded inner tuberosity and a shallower notch at the ental side of the articulating surface; (4) the spines are more solid with a relatively small lumen in contrast to the thin-walled spines with large lumen of the Echidna.

The Proechidna represents a more highly specialized type than the Echidna.

BIBLIOGRAPHY.

Bemmeln, J. F. van.

1899. The results of a comparative investigation concerning the palatine-, orbital-, and temporal regions of the monotreme skull. Proc. K. akad. wetensch. Amsterdam, 30 Sept., 1899, p. 81–84.

1900. Über den schädel der monotremen. Zool. anzeiger, **23**, p. 449–461.

Broom, R.

1900. Note on an Echidna with eight cervical vertebrae. Proc. Linn. soc. New South Wales, **25**, p. 733–734, 1 text-fig.

Chapman, H. C.

1887. Notes on the anatomy of *Echidna hystrix*. Proc. Acad. nat. sci. Phila., 1887, p. 334–335, pls. 14, 15.

Dubois, A.

1881. Remarques sur l'*Acanthoglossus bruynii*. Bull. Soc. zool. de France, **6**, p. 266–270, pls. 9, 10.

1884. Description d'un échidné et d'un perroquet inédits de la Nouvelle-Guinée. Bull. Mus. roy. d'hist. nat. Belg., Bruxelles, **3**, p. 109–114, pls. 4, 5.

Fewkes, J. W.

1877. Contributions to the myology of *Tachyglossa hystrix*, *Echidna hystrix* (Auct.). Bull. Essex institute, **9**, p. 111–137, pls. 1, 2.

Flower, W. H., and Garson, J. G.

1884. Catalogue of the specimens illustrating the osteology and dentition of vertebrated animals, recent and extinct, contained in the museum of the Royal college of surgeons of England. Part II. Class Mammalia, other than man. London: 43 × 779 pp. (Museum has a cast of skull of *Echidna bruijnii* figured by Gervais.)

Flower, W. H., and Lydekker, R.

1891. An introduction to the study of mammals living and extinct. London: xvi + 763 pp., illustr.

Gaupp, E.

1908. Zur entwickelungsgeschichte und vergleichenden morphologie des schädels von *Echidna aculeata* var. *typica*. Denkschr. Med.-nat. ges. Jena, **6**, p. 539–788, pl. 68–75, 59 text-figs.

Gervais, P.

1877. L'échidné de la Nouvelle-Guinée. Compt. rend. Acad. sci. Paris, **85**, p. 837–838.

1877a. L'échidné de la Nouvelle-Guinée. Deuxième note. Compt. rend. Acad. sci. Paris, **85**, p. 990–991; also Journ. de zool., **6**, p. 375–379, practically a reprint of the two preceding.

1877–'78. Ostéographie des monotrèmes vivants et fossiles comprenant la description et l'iconographie du squelette et du système dentaire de ces animaux ainsi que des documents relatifs à leur histoire naturelle. Chapitre deuxième. Les échidnés de la Nouvelle-Guinée. Paris: 4to, fasc. 1, p. 41–56; atlas, folio, pls. 6–9.

Gill, Theodore.

1885. The species of tachyglossids. Ann. rept. board regents Smithsonian inst. for 1884, p. 642–643.

(Calls attention to his proposal of name Zaglossus in 1877.)

Gregory, W. K.

1910. The orders of mammals. Bull. Amer. mus. nat. hist., **27**, p. 1–524, 32 text-figs.

Guillemard, F. H. H.

1886. The cruise of the Marchesa to Kamschatka and New Guinea with notices of Formosa, Liu-Kiu, and various islands of the Malay Archipelago. London: 2 vols., illustr.

Krefft, G.

1868. On the discovery of a new and gigantic fossil species of Echidna in Australia. Ann. mag. nat. hist., ser. 4, **1**, p. 113–114, text-figs. 1–6.

Lubosch, W.

1906. Ueber das kiefergelenk der monotremen. Jena. zeitsch. f. naturw., **41**, p. 549–606, text-figs. 1–3, pl. 26–29.

McKay, W. J. S.

1894. The morphology of the muscles of the shoulder-girdle in monotremes. Proc. Linn. soc. New South Wales, ser. 2, **9**, p. 263–360, pls. 20–23.

Mivart, St. George.

1866. On some points in the anatomy of *Echidna hystrix*. Trans. Linn. soc. London. Zool., **25**, p. 379–403, pls. 52, 53.

Murie, J.

1879. Remarks on the skull of the Echidna from Queensland. Journ. Linn. soc. London. Zool., **14**, p. 413–417, text-fig.

(Remarks on the distinctness of *Echidna* (*Acanthoglossus*) *bruijnii*.)

Owen, R.

1884. Evidence of a large extinct monotreme (*Echidna ramsayi*, Ow.) from the Wellington breccia cave, New South Wales. Phil. trans. Roy. soc. London, **175**, p. 273–275, pl. 14.

1887. On fossil remains of *Echidna ramsayi* (Ow.). Part II. Proc. Roy. soc. London, **42**, p. 390.

Palmer, T. S.

1895. The generic names of the Three-toed Echidna. Science, new ser., **1**, p. 518–519.

Peters, W., and Doria, G.

1876. Descrizione di una nuova specie di Tachyglossus proveniente dalla Nuova Guinea settentrionale. Ann. Mus. civico storia nat. di Genova, **9**, p. 183–187, 1 plate.

1880. Enumerazione dei mammiferi raccolti da O. Beccari, L. M. D'Albertis ed A. A. Bruijn nella Nuova Guinea propriamente detta. Ann. Mus. civico storia nat. di Genova, **16**, p. 664–707, pl. 5–18.

Rothschild, W.

1892. Descriptions of two new mammals from New Guinea. Proc. Zool. soc. London, p. 545–546.

1905. Notes on Zaglossus and description of a new subspecies of *Echidna hystrix*. Novitates zoologicae, **12**, p. 305–306.

S[clater], P. L.

1877. Remarks on the new monotreme from New Guinea. Nature, **15**, p. 257–258, text-figs. 1–2.

Sixta, V.

1900. Vergleichend-osteologische untersuchung über den bau des schädels von monotremen und reptilien. Zool. anzeiger, **23**, p. 213–229, text-fig. 1–3.

THOMAS, O.

1885. Notes on the characters of the different races of Echidna. Proc. Zool. soc. London, p. 329–339, pl. 23–24.

1888. Catalogue of the Marsupialia and Monotremata in the collection of the British museum (natural history). London: xiii + 401 pp., 28 pls.

1907. On the occurrence of Acanthoglossus in British New Guinea. Ann. mag. nat. hist., ser. 7, **20**, p. 293–294.

1907a. A new Acanthoglossus from the island of Salawatti. Ann. mag. nat. hist., ser. 7, **20**, p. 498–499.

TOLDT, K.

1905. Ueber das Genus Proechidna. Verh. K. k. zool.-bot. ges. Wien, **55**, p. 5–11.

1906. Ueber das Haar- und Stachelkleid von Zaglossus Gill (Proechidna Gervais). Ann. K. k. naturhist. hofmus. Wien, **21**, no. 1, p. 1–21, pl. 1–3.

VIALLANES, H.

1879. Observations sur les glandes salivaires chez l'échidné. Compt. rend. Acad. sci. Paris, **89**, p. 910–912 (also translation in Ann. mag. nat. hist., 1880, ser. 5, **5**, p. 83–84).

1880. Observations sur les glandes salivaires chez l'échidné. Ann. sci. nat. Zool., ser. 6, **10**, art. 2, 6 pp., pl. 18.

WEBER, M.

1888. Mededeelingen over zoogdieren. I. Over een nieuwe soort van Proechidna. Bijdr. tot de Dierkunde, feest-nummer, Amsterdam, art. 5, 8 pp., 1 pl.

WESTLING, CHARLOTTE.

1889. Anatomische Untersuchungen über Echidna. Bihang till Kongl. Svenska vet.-akad. Handl., **15**, pt. 4, no. 3, 71 pp., 6 pls.

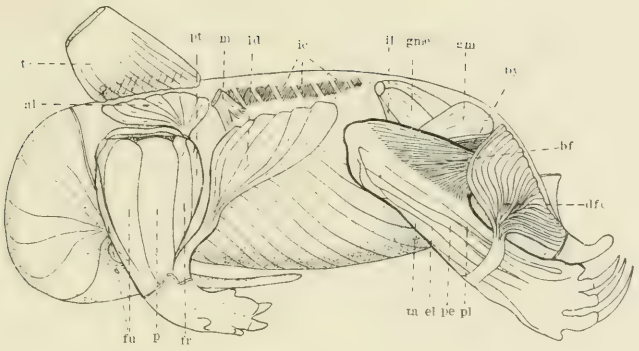
PLATE 1.

Zaglossus bruijnii.

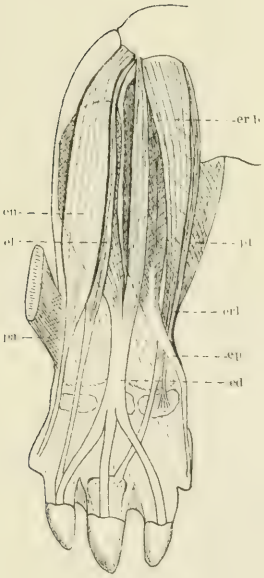
Fig. 1.— Side view, somewhat diagrammatic, to show relations of certain superficial muscles. *al*, anterior portion of latissimus dorsi; *bf*, biceps femoris; *dfc*, dermo-flexor cruris; *el*, extensor longus digitorum; *fr*, flexor carpi radialis; *fu*, flexor carpi ulnaris; *gm*, gluteus maximus; *gme*, gluteus medius; *ic*, iliocostalis; *il*, iliacus; *ld*, the dermo-flexor antebrachii of Fewkes, possibly a portion of the latissimus dorsi; *m*, the dermo-dorsi cervicalis, possibly a derivative of the latissimus dorsi; *p*, flexor profundus digitorum; *pe*, peroneus tertius; *pl*, peroneus longus; *pt*, pronator teres; *py*, pyriformis; *t*, trapezius; *ta*, tibialis anterior. × $\frac{2}{3}$.

Fig. 2.— Extensors of the fore foot. *ed*, extensor digitorum communis; *el*, extensor digitorum lateralis; *ep*, extensor brevis pollicis; *erb*, extensor carpi radialis brevis; *erl*, extensor carpi radialis longus; *cu*, extensor carpi ulnaris; *pa*, ulnar insertion of panniculus; *pt*, pronator teres. × 0.8.

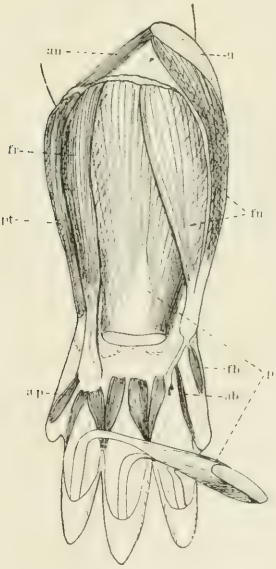
Fig. 3.— Flexors of the fore foot. *ab*, abductor digiti quinti; *an*, anconeus; *ap*, adductor pollicis; *fb*, flexor brevis digiti quinti; *fr*, flexor carpi radialis; *fu*, flexor carpi ulnaris; *p*, flexor profundus digitorum; *pt*, pronator teres; *u*, ulna; the small interossei are shown running from the palm to the bases of the digits. × 0.8.



1



2



3

HELIOTYPE CO., BOSTON.

PLATE 2.

Zaglossus bruijnii.

Fig. 4.— Muscles of the right hind leg, ventral aspect. *af*, adductor femoris, from two heads; *al*, adductor longus; *fld*, flexor longus digitorum; *g*, gracilis (cut); *gas*, gastrocnemius; *pec*, pectineus; *pla*, plantaris; *rf*, rectus femoris; *sa*, sartorius; *sm*, semimembranosus; *so*, soleus; *st*, semitendinosus; *va*, vastus medialis. × 0.6.

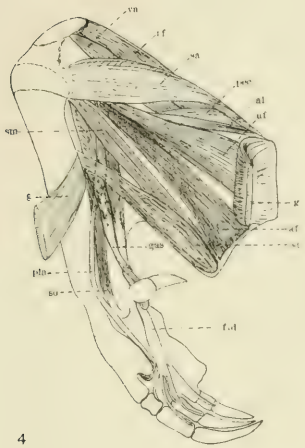
Fig. 5.— Caecum. × 0.6.

Fig. 6.— Spleen, ventral aspect. × 0.6.

Fig. 7.— Larynx, lungs, and heart, ventral aspect. *c*, cricoid; *ce*, ceratohyal; *b*, basihyal; *t*, thyroid; *th*, thyrohyal. The heart is turned forward, exposing the azygos lobe of the lungs. × 0.6.

Fig. 8.— Side view of the skull of an immature Proechidna, showing somewhat diagrammatically the sutures. *bo*, basioccipital; *eo*, exoccipital; *f*, frontal; *if*, interfrontal; *ip*, interparietal; *j*, jugal, greatly expanded, covering part of parietal and squamosal; *m*, maxillary; *n*, nasal; *p*, parietal nearly covered by jugal, its outline shown by broken line; *pm*, premaxillary; *s*, squamosal, partly covered by jugal; *so*, supraoccipital; *t*, temporal canal. × 0.6.

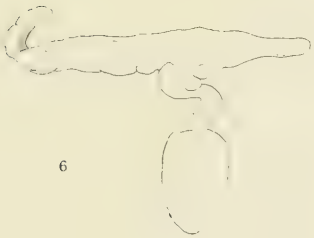
Fig. 9.— Larynx in side view. × 0.6.



4

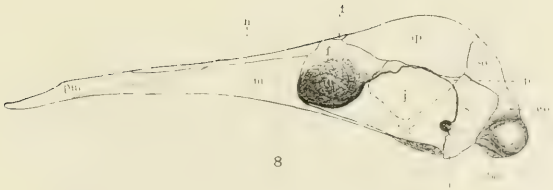
7

5



6

9



8

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XL. No. 6.

BREWSTER'S WARBLER
(*HELMINTHOPHILA LEUCOBRONCHIALIS*)

A HYBRID BETWEEN

THE GOLDEN-WINGED WARBLER (*HELMINTHOPHILA CHRYSOPTERA*)

AND

THE BLUE-WINGED WARBLER (*HELMINTHOPHILA PINUS*).

BY

WALTER FAXON.

CAMBRIDGE, U. S. A.:
Printed for the Museum.
August, 1913.

BREWSTER'S WARBLER (*HELMINTHOPHILA LEUCOBRONCHIALIS*) A HYBRID BETWEEN THE GOLDEN-WINGED WARBLER (*HELMINTHOPHILA CHRYSOPTERA*) AND THE BLUE-WINGED WARBLER (*HELMINTHOPHILA PINUS*).

The real nature of Brewster's Warbler has long been a moot point with ornithologists. Is it a true species, a mongrel, a color-phase of the Blue-winged Warbler, or an atavistic form of the Golden-winged Warbler? Each of the four propositions implied in this question has found advocates among the various authors who have written on the topic, but until now no indubitable proof of the true status of this bird has been obtained.

In January, 1911, I published a paper bearing on this subject, in the Memoirs of the Museum of Comparative Zoölogy, **40**, no. 2; I will here give a *résumé* of the facts recorded in it, a course which seems desirable because these facts were misstated by the reviewer of my article, in The Auk for April, 1911.

In the summer of 1910, there bred within the confines of a swamp of about fifteen acres in Lexington, Mass., a pair of Golden-winged Warblers, and two male Golden-winged Warblers mated with two female Brewster's Warblers. In the same swamp there was also a male Brewster's Warbler that unquestionably was unmated. The progeny of the three pairs were closely observed from the juvenile (in one case, from the natal) plumage up to the first winter plumage, when the adult characters were acquired; the young of the pair of Golden-wings were all Golden-wings; one of the Brewster's Warblers that was mated with a Golden-wing brought forth a homogeneous brood of Brewster's Warblers, while the other produced a mixed brood of Brewster's Warblers and at least one Golden-winged Warbler. A striking thing about it was this: the young birds of mixed parentage were absolutely pure in plumage,— either Brewster's Warblers or Golden-wings, without any tendency to combine, as "intermediates," the characters of the two parents. They appeared to exemplify the transmission of characters in accordance with Mendel's Law, and from that time I had little doubt that Brewster's Warbler itself would prove to be a result of the union

of the Golden-winged Warbler and the Blue-winged Warbler,— a Mendelian so-called dominant hybrid, as Mr. J. T. Nichols suggested in The Auk, Jan., 1908, 25, p. 86.

Since my memoir was published, Golden-winged Warblers and Brewster's Warblers have bred every year in the Lexington swamp. In 1911 Dr. W. M. Tyler and I devoted a good deal of time to them, but without any very definite results. There were during that season at least one male Brewster's Warbler, and one female Brewster's Warbler, together with approximately three male and three female Golden-wings; both Golden-wings and Brewster's Warblers were reared by these birds, but unfortunately we failed that summer to discover how the old birds were paired off.

In the summer of 1912 I lived so far away from Lexington that I was unable to pursue the study of this interesting little colony of birds to any advantage. However, in a visit to the place on the 27th of May, I found a male Brewster's Warbler in song,[1] and on the 4th of July Dr. Tyler saw a male Golden-wing and a female Brewster's Warbler feeding a brood of young birds, one at least of which was a young Brewster's Warbler, while in another part of the swamp he met with a female Golden-wing with a brood containing Golden-wings and Brewster's Warblers assuming their first winter plumage.

In the spring of 1913 I resumed my residence in Lexington and, in association with Dr. Tyler, continued the study of the Warbler colony. The Golden-winged Warbler arrived this year on the 6th of May, a rather early date for this species.[2] The population of the swamp, so far as the birds were concerned in whom we were especially interested, consisted of a male Golden-wing, a female Golden-wing, a male Brewster's Warbler, and a female Blue-winged Warbler. The male Golden-wing was mated with the female Blue-wing, the male Brewster's Warbler with the female Golden-wing. No nests were found, and the manner in which the birds were paired off together was not determined till the young birds had left the nests; in fact neither of the females was seen until then, about the middle of June. All of the old birds were perfectly typical in plumage, the male *leucobronchialis* being one of the pure-plumaged specimens that show not the faintest trace of yellow on the under parts. Here at last we had the combination we had so ardently wished for, but hardly hoped to find,— the Golden-wing mated with the Blue-wing,— and we now followed with keen inter-

[1] I take this opportunity to record another male Brewster's Warbler which I saw in full song near Walden Pond, Concord, Mass., on May 19, 1912.

[2] The average date of arrival of this bird in the neighborhood of Boston, based on my records for 24 years, is May 11. The earliest date within that period is May 3, 1905, the latest May 15, 1908.

est the growth of the young of this pair in their slow progress from the nestling plumage to the first winter plumage. When first seen, on the 15th of June, these young birds were probably not more than two days out of the nest, and both Dr. Tyler and myself saw, or thought we saw, a deeper yellow tint on their breasts and bellies than we had hitherto seen on young *chrysopterae* and *leucobronchiales* of the same age; by the 20th of June, however, this yellow tinge was much less pronounced, and by the 25th of the month, when the tails of the little birds were about three quarters of their full length, the yellow was scarcely apparent, the young still wearing the juvenile dress. Dr. Tyler had fastened a platinum band on the leg of one of the little birds of this family on the 15th of June; we were thus enabled to note the change of color in the same individual as the days wore on,— a change doubtless due to the loss of the fugacious, veiling, yellow tips of the juvenile feathers.

On the 27th of June we saw the first signs of the post-juvenile moult in the loss of one set of wing-coverts with its yellowish bar. By the first of July the contour feathers of the juvenile plumage were being extensively replaced by those of the first winter plumage. As in former seasons (1910, 1911) a marked difference was apparent in the amount of yellow on the under parts of the different individuals of the same brood. In at least one of the brood now under consideration the yellow tint was very faint and it was clear even at this early date that this young one was a *leucobronchialis;* in other members of this same brood the second winter plumage displayed a strong yellow tint on the throat and along each side of the breast and belly, following the area of the *pteryla ventralis* and leaving an ash-colored longitudinal band along the median line of the abdomen, caused by the retention of some of the juvenile set of feathers. As time went on, the yellow color gradually became fainter and restricted for the most part to the breast, leaving the throat and abdomen ashy white; the growth of a black trans-ocular stripe and yellow wing-coverts now perfected the garb of *Helminthophila leucobronchialis.* On the 12th of July at least two of this brood of young birds were as slightly tinged with yellow as the young *leucobronchialis* figured on the plate of my memoir of 1911 (fig. 1). Not one of this brood developed the least trace of the black throat and broad cheek-patch of *H. chrysoptera.*

As I have previously said, the varying amount of yellow, at the same date, in different young Brewster's Warblers of the same brood was noticeable in all of the years in which we observed the growth of the winter plumage in these birds. This may be the result of different degrees of precocity in the individ-

uals composing the brood, or it may be connected with sex, since the female of Brewster's Warbler, I think, always retains a tinge of yellow on the breast, even in the adult. I fancy the rapid loss of the veiling yellow feather-tips is occasioned by their disintegration and dropping off rather than by mere mechanical abrasion and bleaching.

When the female *pinus* was first observed, although she was a typical *pinus* in plumage, both Dr. Tyler and I surmised that she was a so-called impure *pinus* in blood, produced in accordance with the Law of Mendel from one of the many crossings of *chrysoptera* with *leucobronchialis* that, to our personal knowledge, have occurred in this locality during the last four years; in other words, that she belonged to the same family stock as the *chrysopterae* and *leucobronchiales* in the swamp. We even calculated, with lively anticipation, the chances of seeing a Lawrence's Warbler among her offspring,— a more than even chance provided both she and her Golden-winged mate belonged to the mixed stock and raised a brood of four or five young. This expectation (like many a hope staked on young promise for its fulfilment) was not realized; all the young birds grew up to be Brewster's Warblers; yet we had the full satisfaction of demonstrating the true nature of Brewster's Warbler and removing the question forever from the realm of conjecture. That all of the offspring of this pair of birds were Brewster's Warblers would indicate that both of the parents were of pure blood. By the Mendelian Law of transmission a pure *chrysoptera* mated with a pure *pinus* should produce nothing but *leucobronchiales;* a pure *chrysoptera* and an impure *pinus* will produce, on the average, *chrysopterae* and *leucobronchiales* in equal numbers; an impure *chrysoptera* and a pure *pinus*, in like manner, *pinus* and *leucobronchiales* in the same proportion; while an impure *chrysoptera* united with an impure *pinus* would give rise to *chrysopterae*, *pinus*, *leucobronchiales*, and *lawrencei* in equal proportions.

It is interesting to recall to mind in this connection, that Dr. Tyler saw a male Blue-winged Warbler near his house on the 6th of May of this year (Auk, July, 1913, 30, p. 435); this bird sang the normal song of the Blue-winged Warbler,— pretty sure evidence that he was a stranger from the South and not a member of the native Lexington colony of mixed breed, all of whom without exception sing the Golden-wing's song. It is highly probable that on the night of the 5th–6th of May, when there was a heavy migration of Warblers in this region, a small flight of Blue-winged Warblers invaded eastern Massachusetts and that the female Blue-wing that mated with the Golden-wing in the Lexington swamp came in with that flight.

The history of the other pair in the swamp, a male Brewster's Warbler and a female Golden-wing, may be told in a few words. As in one of the two cases of a male Golden-wing joined with a female Brewster's Warbler, considered in detail in my memoir published in 1911, a majority of their issue were Brewster's Warblers, but one of them a male Golden-wing. Dr. Tyler banded two of the little birds belonging to this brood on the 19th of June, when they were but a day or two out of the nest and as like each other as two peas from one pod; one of these grew up to be a typical Brewster's Warbler while the other, its own brother, became a typical male Golden-wing. If any of the birds that were banded (three in all) return and breed in their native place next summer, we may be able to establish a family pedigree for these interesting hybrids, extending through three generations, complete as regards both the male and the female lines.

In my paper published in 1911, after stating the different hypotheses proposed in order to explain the relations existing among the Golden-winged, Blue-winged, Brewster's, and Lawrence's Warblers I added, half in jest, that the only hypothesis left for a new-comer in the field was this: that the Golden-winged and the Blue-winged Warblers themselves were merely two forms of one species. Curiously enough, not long after this I found that this very opinion had been expressed, and in a most unexpected quarter: in a letter dated Edinburgh, Sept. 15, 1835, Audubon wrote to Bachman that he suspected the Golden-winged Warbler and the Blue-winged Warbler were one species![1] That Audubon at that early date, ignorant (as he was assumed to be) of the existence of Brewster's and Lawrence's Warblers, and but superficially acquainted with the Golden-wing, should suspect that two birds so diverse as the Blue-wing and the Golden-wing were one species seemed incomprehensible, and in the light of what we now know about these birds, his surmise seemed to presuppose an almost superhuman faculty of prevision.

As a possible explanation of Audubon's letter I have only this to offer: in the winter of 1876–77 Dr. Spencer Trotter [2] discovered in the collection of the Academy of Natural Sciences of Philadelphia a specimen of Brewster's Warbler without a label, the third specimen known up to that time; on the bottom of

[1] This letter is among the many unpublished MS. letters of Audubon in the Wade collection, generously presented to this Museum by Mr. John E. Thayer.

[2] See Proc. Acad. Nat. Sci. Phila. for 1877, Jan. 1, 1878, p. 292; Bull. Nuttall Ornithol. Club, Jan., 1878, **3**, p. 44, Jan., 1879, **4**, p. 59.

the stand was written in the autograph of John Cassin, "J. C., 20 October, 1862", and also a badly blurred legend "Not [note?] from Bell." An appeal to J. G. Bell elicited the response that he remembered shooting a peculiar Warbler in Rockland Co., N. Y., about the year 1832,— a Warbler something like a Golden-wing, but lacking, although in high plumage, the black throat of that species; a great many years afterward, he sold this specimen in Philadelphia but knew nothing of its ultimate fate. Dr. Trotter justly inferred that the Philadelphia Academy specimen was in all probability the very bird shot by Bell.

Now as Audubon was intimately associated with Bell, is it not possible that he had examined this example of Brewster's Warbler? In that case, seeing that this bird's characters were in part those of the Blue-wing, in part those of the Golden-wing, he may have inferred the interbreeding of these two birds, and so (rather unwarrantably, it is true) their identity. If this be not the explanation of the passage in Audubon's letter to Bachman I have no other to suggest.

When Audubon came to publish his account of the Golden-winged Warbler in 1839 (Ornithological Biography, 1839, 5, p. 154) he said not a word about its connection with the Blue-winged Warbler.

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.

Vol. XL. No. 7.

A NEW MYLODON.

BY

GLOVER M. ALLEN.

WITH FOUR PLATES.

CAMBRIDGE, U. S. A.:
Printed for the Museum.
September, 1913.

A NEW MYLODON.

While collecting fossils in Nebraska, in 1880, for the Museum of Comparative Zoölogy, Mr. Samuel Garman obtained a nearly perfect skull, together with a large part of the skeleton of a Ground-sloth, Mylodon. Since the remains of this genus hitherto discovered in North America have been extremely fragmentary, it seems desirable to publish a brief description of the specimen and to make such comparisons as possible between this and other described species. It proves to be a true Mylodon, approaching in certain respects the genus Paramylodon, and like the latter seems to have been a browsing rather than a grazing type such as *M. robustus* and *M. harlani* must have been. Since it appears to represent an undescribed species, I have named it in honor of its discoverer.

Mylodon garmani, sp. nov.

Type.— Well preserved skull and parts of the skeleton, No. 8429 M. C. Z., from the Pleistocene of the Niobrara River, Nebraska. Samuel Garman, 1880.

Horizon.— The locality is practically the same as that of the Hay Springs fauna, probably Mid Pleistocene, though precise details of the situation are lacking.

General Characters.— A large species of about the size of *M. harlani*, from which it differs conspicuously in the conformation of the last molars, the fifth upper molar being in outline like a figure 8 with a constriction in the middle on either side; the fourth lower molar much elongated and laterally compressed, with the greater axes of the internal lobes nearly longitudinal instead of transverse. Skull high and much narrowed from side to side, with high sagittal crest; pterygoids deep and rounded in side view, palate long and narrow with a very deep and narrow interpterygoid fossa. Edentulous portion of the tip of the rami much contracted.

Description of Skeleton.

In the following description of the type specimen, I have as far as possible made comparison with *Mylodon robustus, M. harlani,* and *Paramylodon*

nebrascensis. Of the first, Owen's classic memoir (1842) treats in detail, and the Museum possesses a mounted skeleton from the Pampas formation of Argentina. No complete account of the North American *M. harlani* has been published, and since the type consisted of but a portion of the lower jaw with the teeth, some doubt attaches to the identification of other fragments of the skeleton later referred to the same species. Cope (1895) first described and figured what are doubtless the upper teeth of this animal, and Leidy and others have described and figured bones which are believed likewise to represent it. No complete skull seems to have been found, but Cockerell in 1909 published an account of a cranium without teeth from Colorado which, after careful comparison of photographs, I believe is identical with *M. harlani*. To the same species are probably referable the teeth on which Cope founded *Mylodon renidens* and *M. sulcidens*, names currently included in the synonymy of *M. harlani*. Cope's *Mylodon sodalis*, based on an ungual phalanx, remains unknown. The description of *M. garmani* follows.

The *skull* (Plates 1, 2) except for the loss of a few chips here and there, is practically perfect and is clearly that of an adult animal. In general outline it resembles that of other species of Mylodon, but is extremely narrow. The dorsal profile is a nearly straight line with a slight depression above the orbit (in the specimen the actual depression is accentuated through a slight crushing in of the skull). The palatal profile is nearly parallel with the general dorsal outline but its plane if produced backward, would pass nearly through the center of the occipital condyles, as in Paramylodon. The pterygoids extend downward from the palatal plane to a distance about equal to one half the height of the braincase. The rostrum in side view is abruptly truncate, its general outline nearly at right angles to the dorsal profile. The upper half is convex, the lower half nearly vertical, or slightly concave, thus resembling Cockerell's specimen from Colorado, here considered *M. harlani*, but differing from Paramylodon, in which the lower half extends gently forward and downward. The maxillae and premaxillae extend some 80 mm. in advance of this boundary. The posterior profile of the skull is gently and evenly convex, beginning at a point on the dorsal margin directly above the posterior base of the squamosal process. Its curve if continued passes through the posterior third of the occipital condyle, thus more as in Paramylodon than in the Colorado skull whose condyles lie mostly outside the posterior outline of the cranium.

In dorsal view, the most striking character is the extreme narrowness of the braincase, whose greatest breadth, measured at the junction with the

squamosal process, is slightly less than the width between the rounded supraorbital processes. The heavy occipital crests meet the strong sagittal crest on the braincase in a slightly overhanging ridge, which passes anteriorly into the smooth surface of the frontal region, with a poorly defined prolongation to the blunt supraorbital angle. The sides of the braincase are nearly vertical and their surface is much roughened for the attachment of the temporal muscles. Anterior to the orbit the rostrum is broader and nearly square, with much less elongation than in Paramylodon. The tips of the nasals, though slightly damaged, seem to have been convexly rounded, and did not project beyond the sides of the muzzle. The latter is slightly inflated and smooth.

The outline of the nasal opening, viewed from in front, is a trapezoid, of which the base, formed by the bones of the palate, is parallel to the top, which is formed by the nasals. The width of the base is nearly double that of the top, so that the sides (*i. e.* the maxillaries) converge dorsally. There is no indication of a bony nasal septum.

The posterior view of the skull is almost horseshoe-shaped in outline, with the convexity dorsal. The extreme narrowness of the braincase is here emphasized by the fact that the extreme height of this occipital face is considerably greater than the width, whereas in the Colorado skull, as in Paramylodon, this face is much wider than high, so that its outline is nearly a semicircle. A strong median ridge extends from the upper lip of the foramen magnum dorsally to the lambdoid ridge which forms the boundary of the posterior face of the skull. On each side between the condyle and the lambdoid ridge is a triangular depression, whose surface is marked by several small ridges, for the attachment of the digastric muscle. The foramen magnum, as in Paramylodon, looks downward as well as backward, and about one half the surface of the condyles is ventral.

In ventral view, (Plate 2, fig. 3) the palate is seen to be long, contracted posteriorly and expanded anteriorly with its greatest width just in front of the first tooth. In contrast to the form of palate shown by *Mylodon robustus*, that of the present species is produced some 50 mm. anterior to a line joining the front edges of the first teeth, and is long, narrow, and very slightly expanded anteriorly, instead of being broad, blunt, and with widely divergent sides. The interpterygoid fossa is extremely deep and narrow. Its walls are parallel, and anteriorly converge to form a pointed arch. The pterygoids are likewise parallel to the long axis of the skull and diverge but little ventrally in contrast to those of the Colorado skull and Paramylodon, in which the pterygoids flare widely apart.

The *mandible*, in comparison with that of the latter genus, is of especial interest. The coronoid process is smaller, and the ramus, instead of tapering strongly towards the symphysis is of nearly the same depth at that point as at the level of the last molar, which is in correlation with the less elongated rostrum.

Certain of the cranial bones and the teeth require further mention.

The *nasals* are broad anteriorly, with a combined width of 70 mm. at the nasal orifice but taper rapidly back to about the level of the orbit, where, on account of the nearly complete disappearance of the median boundary through fusion and by reason of a slight crushing of the frontals, their outlines cannot be traced. Apparently, however, there is little if any indication of a posterior expansion such as Brown figures in Paramylodon.

The *malars* (Plate 3, fig. 7) or jugal bones are complete and separate. Probably they were but loosely articulated with the maxillaries. The upper anterior portion is concavely rounded to form the lower border of the orbit. The ascending wing of the bone has a deep notch for the reception of the squamosal process. In the South American *Mylodon robustus* the portion of bone dorsal to the notch is produced backward so that the distance from its tip to the point of the notch is nearly twice that from the tip of the bone forming the ventral side of the notch to the same point. This bone is not described for any of the North American species nor for Paramylodon, but in our specimen it presents the noteworthy difference that the bony wings forming the sides of the notch are of nearly equal length, the dorsal only some 10 mm. longer than the ventral portion. The descending portion of the malar is similar to that of *M. robustus* in general form but is narrower and longer, with a wider concavity between it and the ascending portion. Its anterior margin is also much less bowed out.

The *premaxillaries* were evidently united, but were only loosely articulated with the maxillaries by a short stem which fitted into a deep median cleft between them at their anterior end. The lateral wings of the premaxillaries bevel over the dorsal surface of the tips of the maxillaries, but are wholly separate from them. The cleft for the reception of this articulating stem of the premaxillaries extends posteriorly as a broad V for about 31 mm., or nearly one half the distance from the tip of the maxillary to the first tooth. It is apparently much deeper in the Colorado skull and in Paramylodon, extending nearly to the level of the large oval tooth (the second in Mylodon). The greatest median length of the premaxillaries is 54 mm., their combined width 96. The tips are thickened and slightly concave below as if for aiding the prehensile power of the lips.

The *palate* is much roughened and pitted, with a narrow rounded ridge passing down the center from the level of the front of the first tooth to a point opposite the back of the penultimate molar. A similar ridge, but apparently of less extent, seems to be indicated in the Colorado skull, beginning on a level with the second tooth. The maxillopalatal suture extends forward to the level of the penultimate molar, and the palatal bone itself is smooth. A large foramen is present at each side behind the last molar.

The *pterygoids* in side view are very large and extend some 75 mm. below the general outline of the palate. In this respect they resemble those of Paramylodon and differ conspicuously from those of *Mylodon robustus* and the Colorado skull in which the pterygoids extend but slightly below the general ventral outline. Their interior surface, except for a narrow roughened rim, is smooth, but the exterior bears many small bony ridges for muscle attachments. There is a broad shallow concavity in the posterointernal part of each.

What appears to be the tympanic bone is a narrow horseshoe-shaped element fused solidly with the os petrosum on each side. Posterior to this is a roughened depression 15 to 20 mm. in diameter for the reception of the articulating process of the stylohyal. The foramina for the eleventh and twelfth nerves are internal to this depression and slightly posterior to it. The latter is the larger, about 15 mm. in diameter.

The *occipital condyles* have the characteristic bordering ridge, said to be absent in Paramylodon. Their ventral surfaces are set obliquely to the frontal plane and constitute more than half the articulating area. In ventral view the transverse diameter is much greater than the longitudinal, 59 and 42 mm. respectively. In the Colorado skull the length of the condyles seems to be greater in proportion to the width.

Teeth.— There are five teeth in the upper and four in the lower jaw on each side. The upper series measures 160 mm. in alveolar length, the lower 156; the toothrows in both jaws converge towards the posterior end of the palate. The last upper tooth is but 21 mm. from the level of the posterior narial opening, a distance equal to about two thirds of its own length. In the Colorado skull the last tooth is much farther from this opening (58 mm.) nearly twice its own length.

The *first upper molar* is the smallest, slightly oval in outline, and a trifle recurved. Its crown therefore is directed posteriorly, and this appearance is further enhanced by a slight bevel due to contact with the anterior part of the crown of the first lower molar. Its diameters at the alveolus are:— longitudinal,

19 mm., transverse 15, thus much the same as in *M. harlani* (see Cope, 1895). The beveled surface of the crown is 20 long. The tooth projects about 19 mm. from the socket and is separated from the second by an interval of only 9 mm.

The *second upper tooth* likewise has its anterior portion recurved so that the crown is directed backward at a small angle to the palate. The front face is slightly beveled by contact with the posterior facet of the first lower tooth, but the crown opposes the second lower tooth. The general outline in section is an ellipse, with a longitudinal diameter of 36 mm., transverse 17, at the alveolus. The tooth figured by Cope (1895) as the second upper molar of *M. harlani* is similar but with a much greater bevel on the anterior face.

The *third upper tooth* has three lobes, an outer with nearly square outline, and two inner, of which the posterior is much the longer with nearly parallel sides and rounded ends. A shallow sulcus separates these two lobes at the lingual side of the tooth. The posterior lobe forms a long heel which is bent at an angle of nearly 45 degrees from the axis of the tooth row toward the median side. The outline is not essentially different from what Cope (1895, pl. 10) figures for *M. harlani* and *M. renidens;* and as nearly as may be judged from a photograph, the tooth is practically the same in the Colorado specimen. The anterior inner lobe is about opposite the single outer lobe, but so deflected is the posterior lobe that its tip is in the same straight line as that of the first. The extreme breadth anteriorly is about 24 mm.; the length in the axis of the tooth row from tip of the anterior inner lobe to the back of posterior lobe is 29.6 mm., while the diagonal from the point of the latter to the tip of the outer lobe is 33 mm.

The *fourth upper tooth* is narrow and compressed in the long axis of the toothrow, but is set at an angle of nearly 45 degrees to the latter. It has three lobes, as does the preceding tooth, two inner and one outer, but the last is considerably in advance of the anterior inner lobe; and the posterior inner lobe is not much elongated, apparently much less so than in *M. harlani* and *M. renidens*, as figured by Cope. In this respect the Colorado skull seems to resemble these two species and to differ from our specimen. There is thus a greater dissimilarity in the shape of the third and fourth upper teeth of our animal than appears in the three others. So compressed is it, that its outline is roughly a parallelogram, slightly concave on the posterior outline. The dimensions are: — tip of anterior inner lobe to tip of outer lobe 30 mm.; from the latter point to tip of posterior inner lobe 35.5 mm.; front of anterior inner to end of posterior inner lobe 19 mm.

The *fifth upper tooth* differs decidedly from that of *M. harlani* and *M. reni-*

dens in that its outline is more that of a figure eight, with a marked constriction or waist which divides the tooth into a slightly larger anterior lobe with the outer corner in advance of the inner, and a smaller posterior lobe only slightly asymmetrical. The long axis of the tooth coincides with that of the toothrow, and measures 30.5 mm.; the breadth of the anterior lobe is 20 and of the posterior 15 mm. In *M. harlani* and in *M. renidens* the tooth has a slightly concave external outline with a more marked internal concavity, but the posterior lobe thus defined does not expand again terminally, and the same is apparently the case in the Colorado skull.

The *mandible* in lateral outline resembles that of *M. robustus*, except that owing to the extreme narrowness of the skull, the symphysis is less broadly truncate. The anterior external openings of the dental canal are three in number, arranged in longitudinal series. The anteriormost is very large, the two others much smaller and subequal. The vertical diameter of the first is 14 mm., of the smaller ones about 7 mm. In Paramylodon the middle foramen is the largest. The predental part of the jaw is much narrowed as seen from above, in marked contrast to the broad square termination of *M. robustus*. This fact points to a narrow extensile tongue, for a browsing, rather than a grazing habit, which makes use of a broad symphysis for cropping. The tip of the jaw is slightly damaged.

As already noticed, the ramus tapers but little in side view, from base of the coronoid process forward, in marked contrast to Paramylodon in which the jaw is but one half as deep at the symphysis as at the base of the coronoid process. Directly above the posterior end of the symphysis, the tip of the jaw slopes upward above the level of the toothrow so that the depth at the extreme tip is quite equal to that at the base of the coronoid process, nearly 105 mm. The condyle is slightly above the level of the toothrow, with its long axis nearly transverse.

The toothrows of the lower, as of the upper jaw, converge posteriorly. The extreme alveolar length of the row is 156 mm. The four teeth are set close together and though of the general Mylodon type, differ in details from those of other species known.

The *anteriormost lower tooth* projects some 24 mm. above the alveolus, and about half that distance above the crowns of the succeeding teeth. In Paramylodon this tooth projects much farther above the alveolus. Its outline is elliptical in section, scarcely reniform, since the inner side is nearly flat instead of concave. The crown presents an anterior and a posterior beveled surface,

the former much more nearly in a transverse plane than the latter. The two facets meet at a point slightly posterior to the vertical axis of the tooth. The long diameter of the tooth, which coincides with the axis of the toothrow, is 25 mm., the breadth 16 mm.

The *second lower tooth* has a broad squarish external lobe, and two narrower internal lobes, of which the posterior is the longer and beveled by contact with upper molar 3. Compared with *M. harlani* the anterior lobe seems better defined by a fairly deep sulcus, which in the latter species is merely a shallow concavity, as figured by Leidy (1855). It corresponds fairly well with the tooth figured by Cope (1895) as the second inferior molar of *M. renidens*, but is smaller. The discrepancies in outlines, however, seem trivial.

The *third lower tooth* has roughly the outline of a boot, of which the toe and heel form respectively the anterior and the posterior external lobes, and the boot leg the longer internal lobe with nearly parallel sides. This lobe is much better marked off than in *M. harlani* or the two species described by Cope as *M. renidens* and *M. sulcidens*, in which the outline is roughly a parallelogram with rounded angles. Indeed, it is difficult to see how these last two can be distinguished from *M. harlani* if small discrepancies are discounted. *M. sulcidens* was named on the basis of a separate third lower molar, closely resembling that of *M. renidens* but with the dimensions of the corresponding tooth of *M. harlani*. According to its describer "the internal extremity of the crown is beveled on the posterior border, so that an obtuse ridge characterizes the posterior side of the crown, which is separated from the posterior border of the external face." The same condition is found in our specimen and is the result of wear against the upper third molar. The differences claimed as separating *M. sulcidens* from *M. harlani*, must, I think, be considered merely individual. The greatest length of the third lower molar is at an angle of nearly 45 degrees to the tooth row, and in our specimen measures 35 mm., practically as in *M. harlani* (33 mm.); the breadth across the two external lobes is 23 mm. as against 20 in the latter.

The *fourth lower molar* is very different from that of any species hitherto known, in its extreme elongation and lateral compression. As in *M. harlani* and Paramylodon it consists of an anterior and a posterior lobe connected by an isthmus. Each lobe has an internal heel. The long diameter of these lobes is nearly transverse to the axis of the toothrow in *M. harlani* and in Paramylodon, but in the specimen here described is at only a slight angle to this axis. On the external side there is a slight concavity opposite the first internal lobe, but this is much more marked in *M. harlani* and in Paramylodon is a sharp depression.

Immediately following it, as in the former, is a slight convexity which is further developed in Paramylodon to form a small but fairly well-defined lobe. The extreme length of the tooth is 64 mm., against 55.5 in *M. harlani* and 56.4 in Paramylodon. Its greatest breadth is 23 mm., across the posterior end.

The *hyoid apparatus* (Plate 3, figs. 5, 6) is complete, and apparently for the first time allows the description of these bones in the genus. The stylohyal is the longest, 130 mm. in extreme length, with an irregularly rounded stem, expanding dorsally into a squarish plate at whose anteroventral corner is a rounded projection for articulation with the skull. Distally it bears a transverse articular surface. What corresponds to an epihyal articulates by a flat surface with the ventral end of this bone. It is compressed laterally and its distal portion is transversely expanded with an elliptical articular facet, 14 × 10 mm., on its posterior face. Its extreme length is 62 mm., or about half that of the stylohyal. A third and smaller bone of trapezoidal outline, with a small elliptical facet on each of its convergent sides, serves for the articulation of the epihyal with the body of the hyoid. This series of three bones is present on both sides, and the two smallest, or ceratohyals, articulate each with the facet of a protuberance marking either end of the body or basihyal. The last is thoroughly ankylosed with the thyrohyals to form a V-shaped bone, whose sides are a little expanded dorsally and whose point is widely emarginate at its posterior border. A small facet at the posterior tip of each cornu probably marks the attachment of cartilage. Leidy has figured (1855, pl. 7, figs. 7, 8) the corresponding bone in *Megalonyx jeffersoni*, but it differs in having the tips of the cornua much smaller, tapering from the body.

The correspondence of the hyoid bones with those of the Nine-banded armadillo, as described by Burmeister (1871) is complete, though his figure of these bones in a young animal indicates that the articular protuberances of the V-shaped arch are actually the ends of the thyrohyals, while the basihyal is a small piece wedged in between them. In the armadillo the stylohyal is shown to be smaller than the epihyal; and the ceratohyal as in Mylodon, is a small ossicle.

Vertebrae.— Of the vertebral column, the cervicals, several dorsal, and a few caudal vertebrae are preserved, but the sacral region and most of the pelvis are lacking.

The *atlas* (Plate 4, fig. 19) is in general similar to that of *M. robustus* as figured by Owen, but at its anterior end is slightly more emarginate in dorsal outline medially. The lateral boundaries are more nearly parallel instead of in-

curved, and the posterior corners are scarcely produced beyond the level of the articular facets, whereas in *M. robustus* they extend considerably beyond them. The positions of the vertebrarterial foramina are very different. In Owen's species the anterior and posterior foramina of the dorsal side are so close together as to be nearly in the same depression, a condition which is fully realized in *Megalonyx jeffersoni*. In our specimen, however, the posterior foramen is 27 mm. behind the anterior and of very much smaller size. The transverse diameters are 18 mm. and 8 mm. respectively. The ventral and posterior aspects of the atlas are much as in *M. robustus*. It measures: — greatest transverse diameter, 193; greatest depth 106; breadth across anterior articulating facets, 117; breadth across posterior articulating facets, 89; least longitudinal diameter in midventral line, 37.

The *axis* (Plate 4, fig. 20) differs from that of *M. robustus* mainly in that the superior margin of the spinous process is at a much less angle to the long axis, due to greater elevation of its anterior projection. The articular facet of the odontoid process faces more ventrally and the cranial articular facets are apparently more elliptical, with diameters 49 × 31 mm. Posteriorly the dorsal spine is deeply hollowed out to receive the spinous process of the third cervical. The height from the ventral border of the centrum to the tip of the spine is 130 mm.; the diameters of the posterior face of the centrum are:— transverse, 54; vertical, 41.

The remaining *five cervical vertebrae* are present though without their transverse processes. The spines of the third and fourth cervicals are thick and rugose, but become more compressed and smooth on those behind. The cranial articular processes become also broader and more roughened on their anterior surfaces. The front edge of the neural spine of the third vertebra is produced in a ridge forward, that fits into a deep hollow in the back of the spine of the axis. In the fourth cervical this ridge does not bow forward but slopes evenly to the tip of the spine, and the same is true of the remaining cervicals. Beginning with the third, the posterior margins of the neural spines are produced backward so as to enfold the anterior edge of the spine next succeeding for about half its height. The result is that the neck vertebrae by thus firmly interlocking, have but little lateral play upon each other. The seventh cervical, as in *M. robustus*, has a concave articular facet for the capitulum of the first rib, situated at each side of the centrum posteriorly. The anteroposterior length of the centrum is about the same (34 mm.) in the third to fifth cervicals but is slightly greater (38) in the two others.

Parts of sixteen *dorsal vertebrae* are preserved, in some cases enough to reconstruct nearly the entire bone. Vertebrae 8 to 13 are almost complete, but of the eight following, the centra and pedicle portion are broken or imperfect so that reconstruction is difficult. Probably there were sixteen dorsals. In *Mylodon robustus* there were sixteen pairs of ribs.

The centrum of the *first dorsal* is roughly elliptical as seen from in front, with a transverse diameter of 59 mm., and a vertical of 40 mm., as measured on the articular surface. The posterior face is not so wide, and like the anterior, bears the demifacets at the sides. The pedicles rise from the anterior upper corners of the centrum, are short, thick, and oval in section. The cranial articular facets are broadly elliptical, with their long axes nearly transverse. The neural spine is some 145 mm. high from the anterior dorsal edge, thin and compressed, but with a greater width posteriorly, where it is ridged vertically. The summit is flattened, its sides diverging posteriorly to a width of 21 mm.

In the *succeeding vertebrae* the centrum becomes more or less triangular in face view. This is first observable in the next but one, (tenth), the posterior face of which is distinctly three-cornered with the ventral point rounded. The sides also are concave. In the sixteenth vertebra the centrum is largest and deepest (62 mm. anteriorly).

With the eleventh vertebra the pedicle increases in length until it arises from nearly the whole side of the centrum; at the same time it becomes gradually much reduced in thickness on successive vertebrae. The cranial demifacets of the ninth vertebra are borne on the anterior base of the pedicel; the caudal demifacets at the dorsal corner of the centrum. The tenth vertebra is similar but the cranial demifacets are more elongated vertically. In the eleventh they become lateral. The caudal demifacets are mainly borne by the posterior base of the pedicle, and seem to become obsolete at about the eighteenth vertebra.

The transverse processes, so far as preserved, are at first broad and irregular in shape, with a prominent anterior point and two posterior ridges. A facet for articulation with the tubercle is present externally. Posteriorly on succeeding vertebrae the two ridges lengthen and diverge forming a Y on the 14th to 16th or 17th vertebrae. The inner fork of the Y at length becomes much the longer until finally it forms a ridge with an obtuse angle. The entire transverse process grows successively more elevated and longer, with a groove of increasing size that passes from the outer to the inner side of the ridge.

The cranial articular facets of the 3d to the 8th vertebrae are all slightly

concave, with the general plane of their surfaces parallel with the frontal plane. They are borne directly over the pedicels, those of the 3d and 4th with their greatest diameter longitudinal, and of the 5th to 8th with this diameter transverse to the direction of the spinal column. This feature, together with the imbrication of the posterior over the anterior ends of the neural spines limits greatly the sidewise movement of the neck vertebrae, but allows much freedom of motion in a vertical direction.

With the ninth vertebra the cranial facets become shifted medially so as to occupy nearly the entire length of each side of the arch. Their plane thus makes an angle of nearly 45 degrees with the transverse axis. The facets themselves measure some 50 mm. in long diameter by 20 in anteroposterior length.

On the tenth and succeeding vertebrae the cranial facets tend to increase in their anteroposterior diameter and to diminish in transverse extent so as to become more or less irregularly rounded from the 13th to 20th. This is accompanied by a flattening of the anterior portion of the vertebra, so that from the 13th onward, these facets look directly upward. The 22d and 23d vertebrae show enlarged facets, those of the former with a slightly different angle of slope at their ventral half, those of the latter practically divided into two contiguous oval facets, the lower partly in advance of the upper and facing slightly outward. The 24th vertebrae is lost, but judging from the caudal articular facets of the 23rd, there were two wholly separate cranial articulations on each side.

A remarkable structure occurs on the 17th vertebra in the shape of a *third caudal* articular facet with the form of an elongated oval, situated on the posterior face of the dorsal spine 30 mm. from its tip and 11 mm. from the paired caudal facets. This articulates with a third median facet of similar shape on the front of the 18th vertebra at the base of the neural spine. The facet on the 17th vertebra measures 39 mm. in length by 14 mm. in breadth. The third posterior facet of the 18th vertebra is broader and not so long (36 × 17 mm.) and 39 mm. from the tip of the spine. That of the 19th vertebra is again longer (52 × 18 mm.) and differs further in that its lower end extends between the tips of the two lateral caudal facets. In the 20th and 21st vertebrae the condition is similar, except that the facet becomes successively smaller (30 × 18 mm., and 25 × 14 mm. respectively). The 22d vertebra (Plate 4, fig. 17) has the anterior third facet, corresponding in size to the posterior facet of the preceding vertebra, but it has none on its posterior surface. This additional articulation is thus present on the posterior face of the 17th and the anterior face of the 22d vertebrae, and on both faces of the four intervening. According to Owen (1842) this

character is absent in the South American *Mylodon robustus*, but is found in Megatherium "through a great proportion of the posterior part of the dorsal region." In connection with the shape of the skull and rostrum it may indicate an adaptation for a browsing rather than a grazing habit through allowing an increased mobility of the trunk in reaching upward for leaves and twigs. (See Plate 4, figs. 17, 18).

The vertebral spines deserve a passing mention. Those of the 3d and 4th vertebrae are low, stout, and rugged, expanded terminally. The remaining cervical spines are destroyed but seem to have become thinner and higher. The 8th, or first dorsal, has a spine some 135 mm. from the median edge of the arch to the tip. The anterior portion is compressed but becomes thickened posteriorly. The spines of the 10th and 11th vertebrae are the longest, about 140 mm. from the lip of the foramen. From this point they increase somewhat in thickness, but diminish slightly and regularly in length, and more in the degree of elevation, so that the posteriormost are much more flattened than those at the anterior end of the column. The summits of the dorsal vertebrae are at first oval (46 × 25 mm. in the 10th vertebra), in outline, but become successively longer, narrower, and from the 16th on, more nearly triangular in outline, with the pointed end anterior. The summit of the 21st vertebra measures 56 mm. in length and 31 in breadth at the posterior end. There is no reversal of the slant of the spines nor any material change in their general shape in the posterior part of the column, as is likewise true of *M. robustus*.

The lumbar and sacral portions of the skeleton had evidently been long exposed above ground, so that nothing but fragments of the pelvis remain, barely sufficient to reconstruct part of the right ilium. The terminal fourteen vertebrae are, however, nearly intact and the centra of three more large caudals likewise are present though somewhat distorted. The 11th to 14th caudals, counting from the terminal one, are of essentially similar appearance. The anterior and posterior faces of the centrum are of practically the same size, nearly circular and about 53 mm. in diameter, but the anterior end is slightly the higher above a transverse plane, and this feature is noticeable in all but the last few caudals. The transverse processes arise along nearly the entire side of the centrum, and measure in the 12th vertebra from the end, 70 mm. from anterior point of union with the centrum to the extreme tip. They are directed backward, and rapidly decline in size to mere lateral ridges in the 7th to the 3d from the end of the series. The last vertebra to have caudal articular facets is the 11th from the end, so that the 10th is consequently the last to have cranial

articular facets. The ascending processes on which these are borne at once become more rod-like and diminish in size to mere protuberances at the anterior edge of the centrum, yet still distinguishable on the penultimate vertebra. In the 7th vertebra from the end, the roof of the neural canal becomes open. The terminal vertebra is a rounded knob, 24 × 20 mm. in transverse and vertical diameters, hollowed slightly on its anterior face and thickened ventrally. A slight median emargination marks its dorsal side. All but the last three caudals have articular facets for the chevron bones. The fourth from the end has fused with the chevron between it and the next anterior vertebra. All the seven chevrons preserved are slightly larger on one side (usually the left) than on the other, and are deeper anteriorly.

Ribs.— Unfortunately the ribs are broken into many fragments and these are preserved in part only. From a study of the vertebrae it seems clear that there were sixteen pairs that had articulation by the head and the tubercle as shown by the facets on those bones. In *Mylodon robustus* there were also sixteen pairs each with double articulation.

A portion of the first rib is preserved, showing it to have been thin but broad, rather short and curved. What were probably succeeding ribs, are represented by thin flattened pieces. The stoutest ribs of all were over 50 mm. broad at the upper portion with the external outline irregularly ridged. The articulating facets are nearly or quite flush with the general surface of the surroundng bone, not raised as tubercles or constricted off. A depression of varying size is present internal to the tubercular facet.

Sternum.— A large portion of the manubrium and five of the sternebra are preserved. The former seems to have been composed of two pairs of elements, thoroughly fused, as indicated by a transverse suture still traceable separating the anterior from the posterior pair. There is a median round perforation extending quite through the anterior portion of the manubrium, indicating the original separation of the two lateral elements. Compared with that of *Mylodon robustus*, the manubrium is much shorter and proportionately broader; the greatest width was apparently about the same as the length, but owing to the loss of parts of the periphery, exact measurements cannot be given. As in the former species one pair of sternal ribs seems to have articulated wholly with the manubrium on lateral protuberances borne at the widest portion and at about one half its length, or just in advance of the second pair of fused sternal elements. Posterior to this is a sudden contraction marking the second portion of the manubrium, whose demifacets for articulation with the second pair of sternal ribs are lost.

Of the remaining sternebra there are five preserved, four of which are apparently consecutive and at the posterior half of the series. These are more or less squarish in dorsal view, with a demifacet at each corner ventrally, the two larger at the anterior corners. As in *M. robustus* the articulation of each sternal rib except the first is by means of these demifacets, and two others borne by a median ventral keel on each sternebrum. In two of the pieces this keel is nearly as long as the sternebrum, in another it is much shorter. The fifth sternebrum has no demifacets at the posterior corners, and so was probably the last to articulate with the ribs. The hinder part of its keel is lost. This piece differs further in its narrowness and greater proportional length. It articulated with yet another posterior piece, which seems to be lost. In *M. robustus* the last piece of the sternum is similar to the one here believed to be the penultimate segment. Following are the measurements of these five pieces:—

	1st	2d	3d	4th	last
Median length of dorsal surface	52	56	59	56	63
Greatest anterior width across demifacets	60	57	63	57	50
Least transverse width (near middle)	51	49	49	40	33
Greatest posterior width	50	55	55	42	41
Greatest length of ventral keel	36	36	51	51	44?
Greatest depth (tip of keel to dorsal border of sternebrum)	—	69	53	55	—

In a mounted skeleton of *M. robustus* in the Museum, there are eight sternebra.

But five of the sternal ribs are entire, and these seem to be of the same type as in *M. robustus*. Two of the smaller measure 157 and 146 mm. respectively in greatest length. Distally there are two oval facets, their tips meeting, which articulate with the facets on the keels of two consecutive sternebra. A short distance proximal to these is a single rounded facet with more or less indication of two faces for articulation with the demifacets at the dorsal corners of the sternebra. The largest sternal rib preserved is 282 mm. long, and differs in having a single large terminal facet instead of two. It has also an oval elevated rugosity 38 × 18 mm., at the first third of its length dorsally, which probably served for muscle attachment. In the middle portion of their length these sternal ribs show a T-shaped or Y-shaped cross section, the stem of which forms a ventral keel. Two other small sternal ribs are flattened and without the keel. In one of these the terminal facets for four articulations are continuous, forming a closed ring. The distal portions of those ribs that did not articulate with the sternum, ended in tapering bony points, one of which is preserved.

Scapula.— Neither scapula is complete but the fragments put together supplement each other. The general form and structure are similar to what Owen has described and figured for *M. robustus*, but the dimensions differ slightly as shown by the following:—

	M. ROBUSTUS	M. GARMANI
Point of coracoid arch to anterovertebral angle	—	290
Glenoid cavity to vertebral border, opposite spine	—	325
Greatest length of glenoid cavity	127	113
Greatest breadth of glenoid cavity	76	73
Longest diameter of supraspinal aperture formed by union of acromion and coracoid	127	150
Shortest diameter of same	76	57
Greatest height of spine	89	84
Diameter of coracoscapular foramen	25	37
Long diameter of clavicular facet	—	44

The spine divides the scapular surface nearly in halves, and is highest at the point where the arch formed by acromion and coracoid, begins; that is, at about 30 mm. from the edge of the glenoid cavity. Its external edge is broadly flattened, 25 to 21 mm. across, then slightly expands to 45 mm. opposite the center of the aperture formed by the fusion of coracoid and acromion. In *M. robustus*, this portion is somewhat wider. The remarkable fusion of the acromion with the so called coracoid is characteristic of the sloths, and the homology of the bones shows that the clavicle articulates as usual with the acromion process, which has thus become greatly extended anteriorly and fuses with the coracoid. The coracoscapular foramen is somewhat larger than in *M. robustus*. This perforation is present in the anteaters as well as the sloths. Concerning the homology of the so called coracoid in the mammals, Ameghino (1909), Lydekker (1893), and Howes (1892) have made critical comparisons among fossil and living Edentates and conclude that the bone to which this name has been applied is not the same as the coracoid of the Reptilia. Lydekker states that in the sloth Bradypus, the coracoid forms part of the glenoid cavity, but this should be verified. In a specimen of Myrmecophaga, in which the sutures of the scapula are still discernible, the coracoid stands directly over the anterior portion of the glenoid, but does not actually form part of it, since it is separated therefrom by the epiphysis of the scapula, that extends forward underneath it. The appearance is at first as if the coracoid formed the anterior portion of the articulation, but this is seen on closer examination not to be the case.

The clavicles are broken, but the portions articulating with the acromion are present. This articulation was by a convex facet slightly constricted off from the shaft of the bone, and elliptical in outline. The shaft is elliptical in section becoming slightly flattened, and apparently more slender than in *M. robustus*.

The *humerus* is essentially similar to that of *M. robustus*, but is perhaps a little smaller as nearly as can be determined in its shattered condition. In side view the head is nearly hemispherical, but from the dorsal aspect is seen to have the condylar surface mainly on its inner half and tapers anteriorly to conform to the general outline of the glenoid cavity of the scapula. Its longest diameter is 111 mm. The great development of the deltoid crest in *M. robustus* is seen likewise in this species. The pectoral crest seems to be less pronounced. From the trochin to the distal end of the deltoid rugosity is 275 mm., against about 256 in Owen's species. From the latter point to the tip of the rounded portion of the condyle is about 155 mm., giving a total length of about 430 mm. for the entire humerus. Owen gives about 445 for *M. robustus*. The distal end has the same peculiar articulating surface, the outer half rounded, more than half a circumference in its anteroposterior extent, the inner half nearly flat. The entire articular surface is 125 mm. in transverse extent, which is about as in *M. robustus*.

The *ulna* is represented by the proximal portion only. The most striking difference in comparison with *M. robustus* is the greater length of the superior, flattened articular surface which is much longer than broad (diameters 97 × 55 mm.), instead of about as broad as long; while the inferior concave articulation is likewise proportionately narrower and is actually separated from the superior facet. A deep depression lies between the two. This inferior articulating surface is contiguous anteriorly with a smaller one, nearly round and flattened in the frontal plane, that serves for articulation with an elliptical facet at the proximal border of the radius. The ulnar has therefore three distinct articulating facets at the proximal end, two for contact with the humerus and one for contact with the radius. To judge from Owen's figure of *Mylodon robustus* the radial facet seems to be distinct from that for the humerus instead of confluent with it.

The *radius* is similar to that of *M. robustus* in size and shape. The proximal end is an elliptical concave facet, whose diameters are 71 and 50 mm. respectively, for articulation with the humerus. On the ventral border of this is the small elliptical articulation for the ulna. Distally the radius gradually

expands to an extreme width of 117 mm., with a median ridge which begins at a point about half way on its length and widens into the roughened distal end. The terminal surface has two chief articulating faces, one concave, the other smaller and convex, for the reception of the carpals. The total length of the radius is 290 mm. or practically the same as in *M. robustus*.

The bones of the fore feet are not all preserved, but most of the *metacarpals* and *phalanges* are represented. These seem to be nearly identical with those of Owen's species, but are a trifle larger and slenderer. Digits 1, 2, and 3 were provided with powerful claws; digits 4 and 5 were clawless, and terminated in blunt, rounded ossicles. The first ungual phalanx (Plate 3, fig. 10) measures 90 mm. in extreme length and differs from the others in having a stem some 25 mm. in length, the long axis of which is bent at an angle with that of the claw-bearing portion. This angle seems much greater than in *M. robustus*. The proximal face is slightly concave. The bony core of the claw is some 55 mm. long, laterally compressed, and regularly tapering in side view to a blunt point. The basal half is surrounded by a thin bony sheath which becomes much thickened and rugose at the base ventrally (Plate 3, fig. 10).

The second ungual phalanx (Plate 3, fig. 9) is without a stem-like proximal portion, but the base articulates directly with the next phalanx by means of two concave facets which are contiguous in the median line, and have their greatest length in a dorso-ventral plane. The sheath at the base of the bony core is extensive, some 45 mm. long laterally. The bony core of the claw is 90 mm. long, slightly decurved, with a thickness from side to side of 26 mm. near the middle. It tapers abruptly to a blunt and rather flattened point. An angular ridge marks off the flattened ventral surface of the claw. The phalanx next proximal to this is short, 53 mm. long, with two rounded facets anteriorly, and a broadly concave facet posteriorly. On each side of the latter, at its ventral corners, is a small squarish facet which evidently articulated with a sesamoid.

The third clawed phalanx (Plate 3, fig. 8) is extraordinarily large and powerful, 180 mm. in extreme length. It is shaped in general like that of digit 2, except that it is more falcate and its inner side has a broad and shallow sulcus beginning near the summit about half way to the point and increasing in breadth and depth to the tip, which it entirely encompasses. The ventral pad for the attachment of tendons is broad, rounded and flattened, about 78 mm. in length from the proximal border of the phalanx. Dorsally the bony sheath extended at least 63 mm. from the base of the claw, and thence forward and downward to the apex

of the ventral disc for tendinous insertion. Apparently the bone is more compressed and deeper than in *M. robustus*.

It was upon a third ungual phalanx and some other phalanges from Oregon that Cope (1878) based his *Mylodon sodalis*. He says that the bony sheath at the base of this large claw is developed on but one side only, and that its place on the opposite side is taken by a prominent rim, tuberculate and notched. His figure, subsequently published (Cope, 1889), seems to indicate a sheath covering the basal third of the claw. The measurements are not very different from those of the specimen studied, but indicate perhaps a slightly more slender claw-bearing portion. Comparative measurements are given under the heading of *Mylodon sodalis*.

The terminal phalanx of the fourth digit (Plate 3, fig. 11) is bluntly pointed with a deep notch about half way on its ventral outline. It is 44 mm. long and articulates with the cotylus of the next proximal phalanx by a facet of an inverted-heart shape, whose lateral portions are very slightly concave.

The fifth digit ends in a small rounded button of 23 mm. in greatest breadth. The next proximal phalanx is an irregularly rectangular bone in dorsal aspect, 42 mm. long, and not so compressed as that of *M. robustus*.

Of the *pelvis* a portion only can be reconstructed from the fragments. This constitutes about a third of the right-hand shield external to the acetabulum, the distance from which to the outer corner is about 250 mm. Along the superior margin there is a rim turning forward at nearly right angles, and of gradually increasing width, as in *M. robustus*. Its edge is roughened and slightly tuberculate for muscle attachment. The structure of the pelvic plate is rather characteristic; the superficial portions are of densely formed bone, while between is a central layer of a porous or cancellar nature. The three layers are rather sharply marked off.

The *femur* is of the same type as that of *M. robustus*, but differs in a few minor details. That of the right side is the better preserved and has an approximate length of some 500 mm., a trifle greater than in Owen's specimen. It shows the concave outline of the inner side, when viewed from in front. The great trochanter extends as a roughened ridge about half the outer length of the shaft. The condyle is large and somewhat hemispherical and differs from that of *M. robustus* as figured by Owen in that the depression for the ligamentum teres is of triangular outline, with the point toward the center of the condyle whereas in Owen's specimen it is broad and expands into a rounded depression. The part of the femur between the condyle and the great trochanter seems

considerably more compressed instead of being nearly the width of the articular head. The distal condyles are of about the size of those in the South American species, but in end view the concavity at the knee for the reception of the patella and its ligaments, is much flatter and apparently a little broader. The femur presents the following measurements:—

Antero-posterior diameter of proximal condyle, *circa*	125 mm.
Lateral diameter of same	118
Depression for ligamentum teres, base, 38; height,	58
Breadth of femur across middle of shaft	165
Width of articular surface for patella (anterior face of knee)	107
Greatest width across distal condyles (posterior view)	198
Greatest width of outer posterior condyle	68
Greatest vertical height of same	58
Greatest width of inner posterior condyle	82
Greatest vertical height of same	97
Ventral width of isthmus between distal condyles	58

The *patellae* are almost squarely truncate across the top, but at the outer upper corner are bordered by a thick ridge of bone that projects above the general dorsal outline. Ventrally the sides of the bone converge to a blunt point. In *M. robustus* there is a raised portion of bone visible along the entire dorsal edge of the articular facet, as seen in posterior view. This facet is of different shape in the two patellae of the specimen studied. In one it is slightly narrower and longer than in the other, 39 to 44, and 113 to 102 in comparative diameters.

The remarkably short and broad *tibia* is nearly identical with that of the South American Mylodon. That of the left side measures in extreme length between uprights 255 mm.; in extreme breadth across the proximal facets, 171 mm. The broad thick shaft contracts to a width of 100 mm. at the middle and expands distally to 131 mm. across the malleoli. Of the two articular facets at the proximal end, the external has a practically flat surface, separated by a depression from the slightly hollowed and larger internal facet. The long axes of both are nearly parallel and at about 45 degrees to an antero-posterior line. In *M. robustus* the smaller facet is of slightly more oval outline with its axis nearly at right angles to that of the larger. These peculiarities are no doubt subject to much individual variation. The outer facet is the upper surface of a projecting shelf whose lower portion forms an articulation for the proximal end of the fibula, of roughly elliptical outline, transversely placed. The internal malleolus at the distal end of the tibia is slightly less expanded than in

M. robustus. The distal facets are similar in both species. The right-hand tibia is nearly 20 mm. shorter than the other, and a similar discrepancy occurs in the fibulae. Leidy (1889, p. 35) gives 10 inches or 233 mm. as the extreme length of the tibia of *M. harlani*. In both it is apparently longer than in *M. robustus*.

The *fibula* is of the same general form as in the South American Mylodon with an obliquely truncate articular surface internally, and a thickened external ridge bearing a small facet for articulation with a sesamoid. The roughened portion at the lower half of the shaft is, however, much less apparent, and the shaft itself is rather smooth throughout. The arrangement of the distal facets is quite different. Of *M. robustus* Owen (1842, p. 116) writes: — "The inner surface of the distal expansion presents a concavity, two flat synovial articular surfaces, and an intermediate rough ligamentous tract. The upperpart of the concavity is very irregular; its lower part is formed by a flat oblique articular surface. * * * A narrow, slightly concave, transverse tract divides the upper from the lower articular surface; this is of less extent than the one above; its plane is vertical, looking directly inwards, and is adapted to the flat surface on the outer side of the astragalus." In the specimen studied the two facets (Plate 4, fig. 21) are present as described, the upper one with its plane slightly oblique, but instead of a "transverse tract" separating the two, their boundaries are contiguous at the angle where the two planes intersect. In this respect the Nebraska specimen is similar to Paramylodon as described by Brown so that the character cannot be ascribed generic value. The astragalar facet occupies about one half the width of the distal end of the bone, and is vertically elongate. The Mylodon fibula described and figured by Williston (1895, p. 175) is larger than either of those studied, and has the two distal facets separated as in *M. robustus*. It was obtained at Seneca, Kansas, from a well, 50 feet below the surface in alluvium. Williston refers it provisionally to *M. harlani*, at the same time calling attention to its apparently larger dimensions, as deduced from Leidy's measurements of tibiae. Its greatest length was 290 mm. Of the two fibulae of the specimen here described that of the left-hand side is the longer, 265 mm.; that of the right-hand side is less, 234 mm. These latter measurements accord more nearly with what may be assumed, from the tibiae, to be the length of fibula in *M. harlani*. As suggested by Williston, his specimen may represent a different species, but until undoubted fibulae of *M. harlani* are found, this point cannot be settled.

The bones of the *hind foot* seem to be essentially similar to those of *M. robustus*, as described and figured by Owen. The peculiarly shaped astragalus is smaller than that of Paramylodon, 140 mm. in greatest width, and 111 mm.

in height, as against 150 and 127 respectively for *P. nebrascensis* as given by Brown. Both calcanea are imperfect but present no especial peculiarities. The hind foot was provided with four toes, of which the two inner bore large claws, as in other species of the genus. Owen considers that it is digit 1 which is wanting. Digit 2 has the smaller and digit 3 the larger claw. That of the former (Plate 3, fig. 13) is straight, conical, and somewhat flattened ventrally. An angular ridge forms the lateral boundary between the upper and the lower surface. A large thickened disk of bone is present at the base of the claw ventrally, below the level of the proximal cotylus. The extreme length of the phalanx is 77 mm.; its greatest depth at the anterior end of the ventral disk 34 mm. The basal sheath of thin bone is largely broken away. The claw of digit 3 (Plate 3, fig. 12) is very large, next in size to the great claw of the manus. Its shape, however, is different, for instead of being practically straight in dorsal view its long axis is bent in a slight arc inward. The distal third is marked with a shallow dorsal groove, and the tip is much flattened dorsoventrally. Compared with the corresponding bone in the mounted specimen of *M. robustus* in the Museum, it is much more slender and laterally compressed. Its greatest length is 167 mm.; its depth at the base 48 mm.

The two phalanges of digit 4 are present, of which the terminal (Plate 3, fig. 14) is a short, bluntly pyramidal bone 42 mm. long, with a deep notch ventrally near the base for tendinous insertion. It articulates with the somewhat square and anteroposteriorly compressed basal phalanx whose ventral border is emarginate for the passage of a tendon, and whose posterior face is deeply hollowed for articulation with metatarsal 4. The terminal phalanx of digit 5 (Plate 3, fig. 15) is similar but smaller.

Dermal Ossicles.— Accompanying the large bones of the body are a number of small dermal ossicles, which are mainly round or ovoid in shape, or occasionally lozenge-shaped. The round ones vary from 3 to 8 or 9 mm. in diameter; one elongate ossicle is 12 mm. in length by 5 mm. in transverse diameter. Another is flattened and squarish, about 8 mm. on a side. These are very different in shape from the dermal ossicles described by Sinclair (1910) for Paramylodon. The latter were found overlying the scapula, and are apparently larger, more often squarish or rhomboid in outline, or irregularly shaped.

Comparison with Mylodon sodalis Cope.

In 1878, Cope named and described *Mylodon sodalis* as a new species, basing his account particularly on an ungual phalanx "from the Pliocene of Oregon," and briefly mentioning other proximal phalanges. Later (1889)

he published a figure of the type phalanx, and in 1893, writes that he had since received from George Duncan, of Paisley, Oregon, an imperfect symphysis mandibuli from near the original locality. He doubtfully refers to *M. sodalis* "the distal part of a femur, lacking part of the internal condyle and adjacent epicondyle" from the Llano Estacado of Texas. It was found associated with species of the Equus fauna similar to those of the Oregon beds at Silver Lake. Matthew (1902) in his list of the Pleistocene fauna from Hay Springs, Nebraska, gives a revision of Cope's list of species from Silver Lake, and includes *Mylodon sodalis* as possibly synonymous with *M. harlani*. He also lists astragali and foot bones of "Mylodon sp." from Washtuckna Lake, Washington, a new locality for the genus. With regard to the ungual phalanx on which Cope founded *M. sodalis*, Osborn (1910, p. 459) suggests that it may prove to be that of a Megalonyx, but Cope's figure published in 1889, seems more nearly to resemble the claw of Mylodon, and is less curved than the large claw of Megalonyx. The original description states that the ungual phalanx "has its basal sheath developed on one side only; its place is taken on the opposite side by a prominent rim, which is tuberculate and notched. The rim is low on the superior part of the proximal extremity, and is separated from the articular cotylus by a concave subvertical surface, wider than long. The basal tendinous insertion is subdiscoid and flat, with a lateral projecting rim, which is pierced at the base by the arterial foramina. The general form of the phalange is more compressed than in *Mylodon harlani*. Its superior middle line is broadly rounded, and continues nearly uniform to the apex. One side is subregularly convex; the other is divided into three planes. The middle one of these is flat, and terminates in a short lateral ridge which extends to the apex. The superior plane becomes somewhat concave near the apex, and the inferior gently convex" (Cope, 1878, p. 385). This description applies well enough to the large ungual phalanx of the fore foot in *Mylodon garmani* but does not indicate that the two are identical. Nor has it been possible to compare Cope's specimen with Paramylodon. Cope gives the following measurements (and in parentheses I have added those of our specimen):—

Length of ungual phalanx	185 mm.	(177)
Vertical proximal depth	58	(59)
Vertical depth at middle of inferior tendinous tuberosity	55	(61)
Vertical depth just beyond inferior tuberosity	44	(37)
Width of proximal cotylus	52	(37)
Width of unguis at middle	33	(30)
Width of unguis near end	20	(15±)

Until more material from the same locality and formation is available, it does not seem best to attempt the definite identification of Cope's *Mylodon sodalis*. The supposed lack of the bony sheath on one side of Cope's type specimen seems more than likely to be due to a breakage, for in one of the phalanges of our specimen a similar appearance is presented where the thin sheath has broken so smoothly away on one side as to suggest that this is its normal condition, but the broken piece was found and fitted perfectly.

Comparative Notes on Mylodon harlani Owen.

This species, though known from numerous fragments from many parts of the southern United States, has never been adequately described. It was based on a portion of the ramus including the lower dentition from Big Bone Lick, Kentucky. Cope (1895) subsequently described and figured teeth from Louisiana, which were assumed to represent the upper series. In the same paper he names two new species, *M. renidens* and *M. sulcidens*, which appear to represent the same animal, and are currently regarded as synonyms of *M. harlani*. Leidy (1885, 1889) lists a number of bones in the collections of the Academy of natural sciences and the Wagner free institute at Philadelphia, including a left malar bone, fragments of vertebrae, and of limb bones and pubis. The complete skull remains unknown. Prof. T. D. A. Cockerell, however, in 1909 published a short account, with photographic figures of a Mylodon cranium discovered on a farm near Walsenburg, Colorado. This he inclined at first to consider the same as *Paramylodon nebrascensis* but decided it might be in reality an undescribed species. Through his kindness I have been able to examine carefully the original photographs as well as drawings of the tooth sockets, made at my request by Professor Cockerell. The upper teeth were five as typically in the genus, and although there are certain resemblances to the skull of Paramylodon, the differences are marked. After a careful comparison with Cope's figures, drawn natural size, of the upper dentition, and allowing for the fact that the diameters of the tooth sockets are several millimeters in excess of those of their respective teeth, I am impressed by the very close correspondence both in form and in measurements between Cope's figures and Professor Cockerell's photographs and drawings, so that there seems little doubt that the Colorado skull should be referred to *M. harlani*, of which no entire cranium had hitherto been discovered.

In 1843, Harlan described as a new species under the name *Orycterotherium missouriense* the remains of three Mylodons found on the Big Bone River, a

tributary of the Osage River, Missouri. These were subsequently examined by Owen who considered them identical with *M. harlani*. Among the specimens are sixteen loose teeth, together with eight others in sockets, two humeri, portions of pelvis, sternum, and foot bones. At about the same time, Dr. H. C. Perkins described with some care a tooth and a humerus found twelve feet below the surface on the Willamette River, Oregon. For these remains, if belonging to an undescribed animal, he proposes the name *Orycterotherium oregonensis* (Amer. journ. sci., 1843, ser. 1, **44**, p. 80, footnote). This humerus is now in the collection of the Boston society of natural history, but the tooth is lost sight of. Leidy (1855, p. 48) further confirms the identity of this bone with *M. harlani*. He describes a humerus from Big Bone Lick, Kentucky (the type locality) and states that its measurements accord with those of the Oregon specimen. This latter is much larger than that of the Nebraska Mylodon here described. It measures:—

Greatest length,	510 mm.
Greatest breadth across distal end,	285
Width across distal condylar surfaces,	155
Antero-posterior extent of same,	87

Harlan in his account of the remains from Missouri gives the total length of a humerus as 20 inches (about 508 mm.), the breadth across the distal condyles, 6 inches (about 152 mm.), which is quite in accord with the dimensions of the Oregon humerus.

In the collection of the Museum of comparative zoölogy there is a fragment of the tip of a Mylodon mandible (Plate **4**, fig. 16) labeled "Walhaumet River, Oregon," which, though it has no further history was evidently received many years ago, before the spelling "Willamette" for this river was adopted. The bone is stained a dark brown like the humerus from the same locality, and it is probable that it is from the same place or even from the same specimen. Assuming that it represents *M. harlani*, it supplies a portion hitherto undescribed, namely the predental part of the jaw. It includes the tip of the left ramus broken slightly to the right of the middle line of the symphysis, with at its posterior edge the basal part of the socket for the first tooth. It is clearly not referable to *Paramylodon nebrascensis*, in which the symphysis is considerably longer and narrower with a decided keel. From the Mylodon whose skeleton I have just described, it differs equally in the breadth of the truncate tip of the jaw, in the nature of the symphysis, and in the arrangement of the openings of the dental canal. These last in the Oregon fragment consist of two large sub-

equal openings, the anterior 25 mm. in advance of the posterior and some 15 mm. in long diameter, with a very small third opening (4 mm. in diameter) below and between these two. In the other specimen on the contrary, the three openings are in a row, the anteriormost large, the two others small. Further, the symphysis of the Oregon specimen is about 109 mm. long or some 15 mm. shorter than in the Nebraska species, and there is at its base a flattened triangular area whose apex extends for nearly 70 mm. toward the tip of the ramus. The terminal part of the ramus was much broader transversely than in either Paramylodon or *Mylodon garmani*; it was more abruptly truncate, and about 120 mm. across as against about 85 in the latter species. It therefore more nearly resembles *M. robustus* in having a broad truncate lower lip, and was thus adapted more for a grazing habit, while Paramylodon and *M. garmani* with their elongate and compressed rami, were probably browsing animals. The reduction of the humerus in the latter may also be correlated with this habit, implying that it raised itself up to reach for branches rather than to grub for roots. The distance from the socket of the first tooth to the tip of the ramus in the median line is about 150 mm. in both species of Mylodon, but in Paramylodon was apparently much greater, since the ramus is more produced in that genus.

Concerning Paramylodon, as to the validity of which some doubt has been expressed, it seems that its claims to generic rank are well founded. Its reduced dentition and elongate rostrum, with other characters pointed out by Brown seem sufficiently trenchant. The contiguity of the astragalar and tibial facets of the fibula, however, cannot be considered of generic value, since this condition is also found in *M. garmani*.

SUMMARY.

Of the genus Mylodon, there were at least two types in the North American Pleistocene, one represented by *M. harlani*, a grazing type; the other represented by *M. garmani*, here described, apparently a browsing type. The one had a broad lip, heavy humerus, tibial and astragalar facets of the fibula separate; the other had a narrower more compressed skull and rostrum, a lighter humerus, tibial and astragalar facets not separated (agreeing thus with Paramylodon). Also, as a further adaptation to the browsing habit, certain of the dorsal vertebrae have three articulating facets for greater mobility in reaching upward, a condition found in Megatherium but not in *Mylodon robustus*, a grazing species of South America.

LITERATURE.

Ameghino, F.

1909. El arco escapular de los edentados y monotremos y el origen reptiloide de estos dos grupos de mamíferos. An. Mus. nac. Buenos Aires, ser. 3, **10**, p. 1–9.

Brown, B.

1903. A new genus of ground sloth from the Pleistocene of Nebraska. Bull. Amer. mus. nat. hist., **19**, p. 569–583, pls. 50, 51.

Burmeister, H.

1871. Osteologische notizen zur kunde der panzerthiere Süd-Amerika's. Arch. anat. phys., 1871, p. 418–429, pl. 11.

Cockerell, T. D. A.

1909. A fossil ground-sloth in Colorado. Univ. Colo. studies, **6**, p. 309–312, 2 pls.

Cope, E. D.

1871. Preliminary report on the Vertebrata discovered in the Port Kennedy bone cave. Proc. Amer. phil. soc., **12**, p. 73–102.

1878. Descriptions of new extinct Vertebrata from the Upper Tertiary and Dakota formations. Bull. U. S. geol. geogr. surv. terr., **4**, p. 379–396.
(*Mylodon sodalis* described, p. 385).

1889. The Edentata of North America. Amer. nat., **23**, p. 657–664, pls. 31, 32.

1893. A preliminary report on the vertebrate paleontology of the Llano Estacado. 4th Ann. rept. Geol. surv. Texas, 1892, 136 pp., 23 pls.
(*Mylodon ?sodalis* from Texas).

1895. On some Plistocene [*sic*] Mammalia from Petite Anse, La. Proc. Amer. phil. soc., **34**, p. 458–468, pl. 10–12.
(Describes *M. renidens* and *M. sulcidens*).

1899. Vertebrate remains from Port Kennedy bone deposit. Journ. Acad. nat. sci. Phila., ser. 2, **11**, p. 193–286, map.

Harlan, R.

1843. Description of the bones of a new fossil animal of the order Edentata. Amer. journ. sci., **44**, p. 69–80, 3 pls.

Holmes, F. S.

1858. Remains of domestic animals among Postpliocene fossils in South Carolina. Charleston, S. C., 8vo, 16 pp. Review in Amer. journ. sci., 1858, ser. 2, **25**, p. 442, 443.
(Teeth of *Mylodon harlani* from Ashley Ferry, S. C.).

Howes, G. B.

1892. Notes upon the shoulder girdle of certain dicynodontoid reptiles. Journ. anat. phys., **26**, p. 403–405.

Leidy, J.

1853. [On some fossil teeth]. Proc. Acad. nat. sci. Phila., **6**, p. 241.
(Mylodon teeth named *Eubradys antiquus* and *Ereptodon priscus* = *nomina nuda*).

1855. A memoir on the extinct sloth tribe of North America. Smithsonian Contrib., **7**, 68 pp., 16 pls.
(Type of *M. harlani* figured and known specimens listed).

1884. Fossil bones from Louisiana. Proc. Acad. nat. sci. Phila., 1884, p. 22.

Leidy, J.

1885. Remarks on Mylodon. Proc. Acad. nat. sci. Phila., 1885, p. 49–51.

1889. Notice of some mammalian remains from the salt mine of Petite Anse, Louisiana. Trans. Wagner free inst. sci., **2**, p. 33–40, pl. 5.

Lydekker, R.

1893. Note on the coracoidal element in adult sloths, with remarks on its homology. Proc. Zool. soc. London, 1893, p. 172–174.

Matthew, W. D.

1902. List of the Pleistocene fauna from Hay Springs, Nebraska. Bull. Amer. mus. nat. hist., **16**, p. 317–322.

Merriam, J. C.

1906. Recent discoveries of Quarternary mammals in Southern California. Science, new ser., **24**, p. 248–250.
(Dermal ossicles of Paramylodon).

Osborn, H. F.

1910. The age of mammals in Europe, Asia and North America. New York, 8vo, xvii + 635 pp., illustr.

Owen, R.

1842. Description of the skeleton of an extinct gigantic sloth, *Mylodon robustus*, Owen, with observations on the osteology, natural affinities, and probable habits of the megatherioid quadrupeds in general. London, 4to, 176 pp., 24 pls.

1843. Letter from Richard Owen, Esq., F. R. S., F. G. S., &c., &c., on Dr. Harlan's notice of new fossil Mammalia. Amer. journ. sci., **44**, p. 341–345.

Perkins, H. C.

1842. Notice of fossil bones from Oregon Territory, in a letter to Dr. C. T. Jackson. Amer. journ. sci., **42**, p. 136–140, 4 figs.

Sinclair, W. J.

1910. Dermal bones of Paramylodon from the asphaltum deposits of Rancho la Brea, near Los Angeles, California. Proc. Amer. phil. soc., **49**, p. 191–195, fig. 1.

Williston, S. W.

1895. New or little known extinct vertebrates. Kansas Univ. quarterly, **3**, p. 165–176, pl. 14–19.
(Fibula of Mylodon from Kansas figured).

PLATE 1.

PLATE 1.

MYLODON GARMANI.

Fig. 1.— Side view of skull.
Fig. 2.— Side view of jaws (tip of left ramus slightly broken).

1
2

PLATE 2.

PLATE 2.

MYLODON GARMANI.

Fig. 3.— Ventral view of skull.
Fig. 4.— Lower jaws from above.

3

4

PLATE 3.

PLATE 3.

Mylodon garmani.

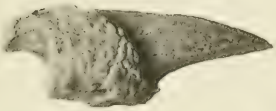
Fig. 5.— Complete hyoid apparatus in lateral view.
Fig. 6.— Anterior view of the body of the hyoid.
Fig. 7.— Jugal in side view.
Fig. 8.— Third ungual phalanx of fore foot.
Fig. 9.— Second ungual phalanx of fore foot.
Fig. 10.— First ungual phalanx of fore foot.
Fig. 11.— Terminal phalanx of fourth digit of fore foot.
Fig. 12.— Ungual phalanx of digit 3 of hind foot.
Fig. 13.— Ungual phalanx of digit 2 of hind foot.
Fig. 14.— Terminal phalanx of digit 4 of hind foot.
Fig. 15.— Terminal phalanx of digit 5 of hind foot.

6

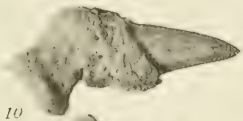
7

5

8

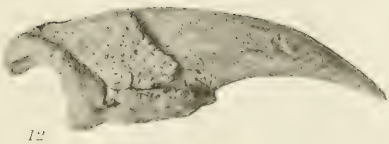


9

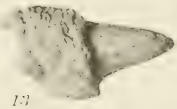


10

11



12



13

14

15

PLATE 4.

PLATE 4.

Mylodon garmani.

Fig. 16.— Tip of left ramus of a Mylodon from Oregon, considered as representing *M. harlani*.

Fig. 17.— Portion of a dorsal vertebra showing three articulating facets anteriorly. On its posterior side there are but the usual two facets, since it is the last of the three-faceted vertebrae.

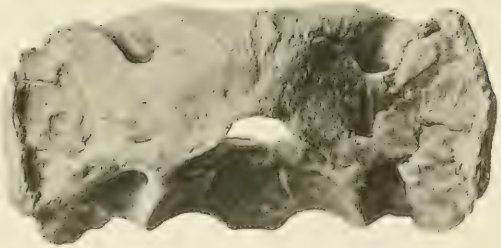
Fig. 18.— Spine of one of the vertebrae anterior to the last, showing three facets on its posterior aspect.

Fig. 19.— Dorsal view of the atlas.

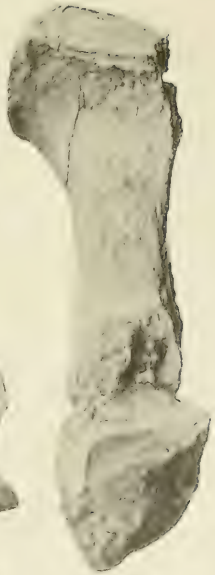
Fig. 20.— Lateral view of the axis.

Fig. 21.— Ental aspect of the fibula, showing (at the right-hand end) the facet for articulation with the upper end of the tibia, and (at the left-hand end) the astragalar and the tibial facets at nearly right angles but in contact. The surface of the former is slightly crushed.

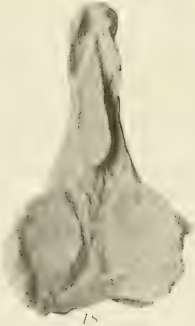
17



19



21



18

16

20

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XL. No. 8.

NOTES ON THE CRAYFISHES

IN THE

UNITED STATES NATIONAL MUSEUM

AND THE

MUSEUM OF COMPARATIVE ZOÖLOGY

WITH DESCRIPTIONS OF NEW SPECIES AND SUBSPECIES

TO WHICH IS APPENDED

A CATALOGUE OF THE KNOWN SPECIES AND SUBSPECIES.

BY

WALTER FAXON.

With Thirteen Plates.

CAMBRIDGE, U. S. A.:
Printed for the Museum.
July, 1914.

PREFATORY NOTE.

The following notes on Crayfishes were made during an examination of all the Crayfishes that have been received at the United States National Museum and the Museum of Comparative Zoölogy since my last paper on these animals was published in the Proceedings of the United States National Museum, Feb. 7, 1898, 20, p. 643–694, pl. 62–70. I am deeply indebted to the authorities of the National Museum for sending to me the vast amount of material that has come to Washington since my last review of the subject. I am also indebted to Mr. W. P. Hay of Washington, Prof. S. E. Meek of the Field Museum of Natural History, Chicago, Ill., and Dr. A. E. Ortmann of the Carnegie Museum, Pittsburgh, Pa., for the loan of specimens.

NOTES ON THE CRAYFISHES.

Astacopsis australasiensis (Milne Edwards).

Astacus australasiensis M. Edw., Hist. Nat. Crustacés, 1837, **2**, p. 332, pl. 24, f. 1–5.

There are two cotypes of this species in the Museum of Natural History in Paris. One of these, a female, has been kindly loaned to me by Prof. E. L. Bouvier. The rostrum of this specimen is long-triangular, excavated, the acumen provided with an upturned, blunt, apical denticle and a similar denticle on each side; behind the lateral denticles the margins of the rostrum are obscurely crenate. The post-orbital ridges terminate anteriorly in a blunt tubercle; they are channelled throughout their length and are followed by two obsolescent tubercles at a little lower level on the gastric region; the hepatic area also is tuberculated and a few less prominent tubercles are visible on the posterior margin of the cervical groove on each side of the carapace. The areola is broad, narrowing from before backward, punctate. Branchial regions obsoletely squamose. Abdomen rather smooth, with a submarginal row of small tubercles on the pleura of the second somite; pleura rounded. Spine on dorsal face of inner branch of posterior abdominal appendages *submarginal*. Antennal scale of moderate width, flanked with a sharp denticle on the outer side at the base. Anterior process of the epistome triangular, with convex sides, ending anteriorly in an attenuated angle. Chelipeds nearly symmetrical, meros armed below with spines biserially disposed, upper margin thereof also furnished with a few (three or four) spinules; upper margin of carpus armed with two prominent spines, the distal the larger; outer face furrowed longitudinally, slightly tuberculate along the upper edge of the furrow; inner face of the carpus somewhat tuberculate and armed with one spine in the middle of the distal border. Propodite distinctly carinate on the upper border, less distinctly so on its lower border; the superior crest is cut into five teeth, the lower margin is denticulate; the outer face of the propodite is thickly covered with depressed tubercles. Dactylus furnished with one denticle near the proximal end of the upper border. Length, 63 mm.; length of carapace, 30.5 mm.; breadth of carapace, 13 mm.; length of areola, 9 mm.; breadth of areola at anterior end, 6 mm., at posterior end, 4.5 mm.; length of chela, 20 mm.; breadth of chela, 10 mm.; length of dactylus, 11.5 mm.

Bay of Sydney, Verreaux, No. 944, 1837.

I doubt if this is the specimen figured by Milne Edwards: he gives as the length of the body, two inches; the figure, which is said to be life size, is 56 mm. long.

Dr. Giuseppe Nobili [1] also has examined the same cotype belonging to the Paris Museum and is convinced that it belongs to the same species as a male specimen, 66 mm. long, in the Museum of Natural History of Genoa, said to have been collected by D'Albertis in 1872 on the little island of Sorong in the Strait of Galevo, northwestern coast of New Guinea. Perhaps a misplacement of labels has occurred in this case; the extraordinary distribution of this species implied by the nominal locality label accompanying the Genoa specimen, as well as the nature of the islet of Sorong, make it probable that the specimen was in reality secured at Sydney, Australia, where D'Albertis collected in 1873.

Astacopsis australasiensis may turn out to be nothing but an immature stage of *A. spinifera*.

Astaconephrops albertisii Nobili.

Astaconephrops albertisii Nobili, Annali Mus. Civ. Storia Nat. Genova, 1899, **40**, p. 244; Bolletino dei Musei di Zoologia ed Anatomia Comparata di Torino, June 9, 1903, **18**, p. 1.

The genus Astaconephrops, with its one species *albertisii*, based on a single female specimen in the Museum of Genoa which is said to have come from Katau on the southern coast of New Guinea, needs further elucidation. According to Nobili the margins of the rostrum (which in a general way resembles the rostrum of Paranephrops) are continued back, in the shape of two keels, over the carapace to the cervical groove; the abdominal segments are produced into points laterally; the inner branch of the last pair of abdominal appendages is furnished with a rib or keel on the dorsal face, terminating in a spine *near the centre* of the branch; the chelae are long and slender and on account of the elevation of the middle of the two faces appear subprismatical; the carpus is cylindrical, or rather depressed, and armed on the inner side with a sharp spine concealed in a large tuft of hairs; the inner margin of the palm is furnished with minute teeth, all the rest of the palm being smooth; the fingers are unarmed, but provided with hairs along their cutting edges.

From the description of this animal given by Nobili one would infer a combination of the characters of Nephrops, Paranephrops and Cheraps. The

[1] Contribuzioni alla Conoscenza della Fauna Carcinologica della Papuasia, delle Molluche e dell' Australia. Annali del Mus. Civ. Storia Nat. Genova, 1899, **40**, p. 246.

branchial formula is the same as in the genus Cheraps, and essentially the same as in Paranephrops; but according to Nobili the podobranchiae of the eighth and ninth somites are not furnished with an ala or lamina in the genus Astaconephrops, whereas in the genus Cheraps these podobranchiae are alate.

Parastacus araucanius, sp. nov.

Plate 4.

Male:— Cephalothorax shorter than the abdomen, strongly compressed laterally, mostly smooth, minutely granulated on the sides; areola broad (about two thirds as broad as long), minutely punctated; rostrum short, not reaching the distal end of the second antennulary segment, margins elevated, slightly convergent from base to near the tip, where they abruptly converge to form the abbreviated acumen; the infero-lateral edges of the rostrum are visible from above, forming the superior border of the orbit separated from the supero-lateral edge of the rostrum by a groove; distal half of the rostrum concave above; antero-lateral margins of the carapace produced into a prominent, rounded angle below the small eye which lies in a deep and uncommonly complete orbit. Post-orbital ridges, obsolete. The pleural angles of the abdomen are rounded, the telson long with a pair of lateral spines and a longitudinal median furrow on its upper face along its distal half; the median rib on the upper side of the inner branch of the last pair of abdominal appendages ends in a small spine situate a little distance from the margin. Antennal scale short and broad. The chelipeds are asymmetrical, the right one being the larger; the meros is tuberculated on its lower face, granulate on the superior margin, but destitute of spines; the surface of the carpus is lightly squamoso-granulate, the granulations becoming more pronounced on the supero-interior edge where they take the form of blunt tubercles; the chela, too, is lightly squamoso-granulate, without any prominent spine or tubercle, except one blunt tubercle or tooth near the base of the immovable finger; the superior and inferior borders are rounded.

Dimensions. Length, 42 mm.; length of cephalothorax, 19 mm.; length of areola, 6 mm., breadth of areola, 4 mm.; length of larger claw, 15.5 mm., breadth of do., 7 mm., length of dactylus, 8.5 mm.

Corral, Chile, Dec. 18, 1908, in a cascade stream. Thomas Barbour coll., M. C. Z., No. 7,355.

This species is related to *P. nicoleti* (Phil.) and *P. hassleri* Fax. Like these it has a strongly compressed cephalothorax, indicating a burrow-dwelling species.

It differs from both of these species in its short and broad areola. Compared with *P. nicoleti*, it differs in the lack of sculpture of the chela and carpus. Compared with *P. hassleri*, the rostrum is shorter, broader, and more abruptly truncate, the chela is rounded above and below and unprovided with the crest-like series of low, squamous tubercles.

Six species of Parastacus have been previously described from Chile, viz.:— *P. chilensis* (M. Edw.) in 1837, *P. spinifrons* (Philippi) in 1882, *P. nicoleti* (Philippi) in 1882, *P. bimaculatus* (Philippi) in 1894, *P. agassizii* Fax. in 1898, and *P. hassleri* Fax. in 1898. The type of *P. chilensis*, a single dry specimen, is in the Muséum d'Histoire Naturelle in Paris, and should be more fully described, since Milne Edwards's diagnosis (Hist. Nat. Crust., 1837, **2**, p. 333) is entirely insufficient. In 1849 (Gay's Hist. Chile, Zool., **3**, p. 211, Atlas, **2**, Crust. pl. 1, f. 4) Nicolet described and figured as *Astacus chilensis* M. Edw. a crayfish certainly different from Milne Edwards's species, and R. A. Philippi therefore gave Nicolet's species a new name, *Astacus nicoleti*, in a paper published in the Anales de la Universidad de Chile, 1882, **61**. In a paper published in 1898 when I was ignorant of Philippi's paper, I also gave a name to Nicolet's crayfish, fortunately the same name that had been already given it by Philippi. In the same paper Philippi describes and figures a new species, *Astacus spinifrons;* the diagnosis is as follows:— A. rostro elongato-triangulari ad basin utrinque spinula acuta; carpo extus profunde sulcato, margine superiore grosse tuberculato; mano crassa subtus rotundata; digitis haud lineato-sulcatis, intus basi longe barbato-ciliatis.

In 1894 Philippi [1] published a description of another new species of Parastacus from Chile under the name of *Astacus bimaculatus*. This is probably the species which I described later by the name of *Parastacus agassizii* (Proc. U. S. Nat. Mus., 1898, **20**, p. 690).

Parastacus spinifrons (Philippi).

Plate **9**, Fig. 1.

Astacus spinifrons Philippi, Anales Univers. Chile, 1882, **61**.

A male Parastacus in the Museum of Natural History, Paris, sent to me for identification by Prof. E. L. Bouvier, I think belongs to this species. It differs,

[1] Dos Palabras sobre la Sinonimia de los Crustáceos, Decápodos, Braquiuros o Jaivas de Chile. Anales Universidad Chile, 1894, **87**, p. 369–379. I have been unable to consult either of Philippi's memoirs directly. Miss Rathbun, however, has kindly furnished me with a transcript of the earlier one, copied from the volume of the Anales in the Library of Congress, Washington, and Dr. A. E. Ortmann has courteously lent me a MS. copy of the later paper, given to him by F. Philippi, son of the author, about 1900.

it is true, from Philippi's figures of *P. spinifrons*, at least from the copy of those figures in Dr. Ortmann's possession, in some respects, for instance the rostrum is shorter and broader and the immobile finger of the large claw is much longer. These discrepancies may be due to the inaccuracy of the original figures or of the copy of these figures which is all that I have before me. Philippi's diagnosis, moreover, takes no account of the pronounced asymmetry of the chelipeds, a marked feature of the specimen from the Paris Museum. I append a description of the latter; future explorations in Chile will determine whether it is the same species as Philippi's.

Cephalothorax subcylindrical, smooth, shorter than the abdomen; areola broad, considerably less than one half the length of the anterior section of the carapace; rostrum triangular, reaching to the distal end of the second antennulary segment, upper surface plane, with slightly elevated margins; post-orbital ridges obscurely marked except anteriorly where they form an elongate, low, tubercle without an acute spine; the antero-lateral angle of the carapace is produced to a prominent blunt angle below the orbit; there is no lateral or branchiostegian spine. The abdominal pleura are broad, with rounded angles. The antennal scales are broad, broadest in the middle; lower surface of the peduncle of the antenna hairy; epistoma triangular, anterior angle acute; third pair of maxillipeds clothed with dense hair below. Chelipeds unsymmetrical, the right one being much the larger, meros pretty smooth, except on its lower face which is provided with a row of small marginal tubercles and clothed with a heavy coat of hair; the superior margin of the meros is destitute of a spine; the carpus has a deep longitudinal groove along its external face; below this groove the surface is smooth, above it there are small squamous tubercles which on the superior border of the carpus assume the form of prominent tubercles, or blunt teeth, four or five in number; the infero-interior face of the carpus of the larger cheliped is likewise furnished with similar tubercles; the right (larger) claw is very thick, with rounded superior and inferior borders; the body of the claw is beset with flattened low tubercles which are most pronounced anteriorly, near the socket of the dactylopodite; the fingers gape, are pitted in place of being tuberculated, and there are about three blunt teeth on the cutting edge of each finger, one of which is especially prominent; both fingers are heavily bearded at the base, especially on the inner side; the left (smaller) claw is nearly smooth, with long and slender fingers that meet throughout their length, destitute of teeth but furnished with a beard at the base, like the larger claw. Inner branch of the last pair of abdominal appendages armed with a submarginal spinule at

the distal end of the median rib. Length, 90 mm., length of carapace, 41 mm., width of carapace, 20 mm., width of base of rostrum, 6.5 mm., length of rostrum, 9 mm., length of areola, 11.5 mm., breadth of areola, 7 mm., length of antennal scale, 7 mm., greatest breadth of do., 4 mm., length of larger claw, 31 mm., breadth of do., 17.5 mm., length of superior margin of hand, 10 mm., length of dactylus, 19 mm., length of smaller chela, 23 mm., breadth of do., 9 mm., length of dactylus, 16 mm.

There are four specimens of this species in the U. S. National Museum from the rivulets of MM. Bock and Jones, Lake Nahuel Huapi, on the eastern slope of the Cordilleras in Argentina. The chelipeds are preserved in three of these specimens; in two the larger claw is on the left side, in one it is the right, as in the Paris specimen.

The tip of the rostrum is setose in this species, and in most cases there are a pair of minute, horny, bead-like lateral teeth just back of the point of the rostrum. The rostrum is therefore essentially like that of *P. bimaculatus*. From the latter the present species differs in having much stouter, shorter-fingered, more heavily tuberculated claws, and a somewhat longer metathorax and narrower areola.

Parastacus agassizii (= *bimaculatus*) has been recorded from Lake Nahuel Huapi by Ortmann (Proc. Amer. Philos. Soc., **41**, p. 293). The specimens should be examined anew with reference to the possibility of their belonging to the present species, *P. spinifrons?*

Specimens from Puerto Montt, Lake Llanquihué, on the opposite slope of the Cordilleras, in Chile, are said by Doflein (Sitzungsber. Akad. Wissensch. München, 1900, **30**, p. 133) to agree wholly with my description of *P. agassizii*[1] (= *bimaculatus*).

Parastacus bimaculatus (Philippi).

Astacus bimaculatus R. A. Philippi, Anales Universidad Chile, 1894, **87**, p. 378 (Chile).

Parastacus agassizii Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 690, pl. 70, figs. 4, 5 (Talcahuano, Chile). Doflein, Sitzungsber. Akad. Wissensch. München, 1900, **30**, p. 132 (Puerto Montt, Lago Llanquihué, Chile). Lenz, Zool. Jahrb., Supp., May 2, 1902, **5**, p. 736 (Tumbes, Chile). Porter, Revista Chilena de Hist. Nat., Dec. 31, 1904, **8**, p. 258, Pl. 9 (Contulmo and Chillán, Chile).

[1] The error in the branchial formula of *P. agassizii* as it appears in my paper in the Proc. U. S. Nat. Mus., 1898, **20**, p. 692, has been pointed out by Doflein. This error was due to an unfortunate dislocation of the table in printing, as is evident on comparing the table of the branchial arrangement in the genus Parastacus on p. 683.

A single specimen of this species has been lately received at the Museum of Comparative Zoölogy from Valparaiso, Chile.

As noted above, *P. agassizii* has been recorded from Lake Nahuel Huapi in Argentina by Ortmann (Proc. Amer. Philos. Soc., **41**, p. 293). Specimens from this locality in the U. S. National Museum belong to a different although similar species, *P. spinifrons* (Phil.)? and Dr. Ortmann's determination should therefore be verified.

I think that my *P. agassizii* is the same species as the one previously described by R. A. Philippi in 1894 under the name of *Astacus bimaculatus*. Philippi's description is as follows:—

"Astacus bimaculatus Ph.

"A. cephalothorace utrinque macula magna triangulari, albida notato; rostro elongato, peracuto, utrinque ante apicem denticulo armato, unde lineae elevatae sensim divergentes nascuntur; chelis valde inaequalibus, sinistra majore; carpo ejus extus inflato, velut bullato, margine superiore unispinoso; digitis gracilibus, denticulatis. Longit. corporis 72 mm., chelae majoris 37 mm.

"El color del cuerpo es oscuro siendo una mezcla de negro verdoso i de pardo rojizo, como en las demas especies, i en cada lado se ve una gran mancha triangular blanquizca; su superficie es lisa, pero las patas anteriores están cubiertas de granulaciones bastante gruesas, que faltan solo en la parte inflada del carpo. El pico es casi tan largo como la escama situada en la base de las antenas esteriores; se adelgaza paulatinamente en una punta mui aguda e inclinada. De cada lado i mui cerca de la punta se notan dos dientecitos puntiagudos, de donde parten listones bastante elevados i agudos, qui diverjen paulatinamente. Un dientecito mui puntiagudo se observa tambien ante el borde de la órbita. Las patas anteriores son mui desiguales, la izquierda es mucho mas larga i sobre todo mas gruesa; por lo demas su hechura es la misma. En el borde superior del artículo tercero se nota una espina, i dos o tres en el borde inferior. El carpo muestra tambien una o dos espinas en su borde superior, i en su lado esterior una hinchazon casi semi-globosa, mui notable en el carpo izquierdo, menor pero bien aparente en el derecho. La mano es mucho mas angosta i estirada que en las otras tres especies chilenas, sobre todo los dedos, cuyo borde interior es finamente dentado. Las otras partes del cuerpo no ofrecen nada de particular."

This description agrees pretty well with the species which I described as *P. agassizii*, but I do not know what Philippi means by asserting that the figure of *Astacus fluviatilis* in the Régne Animal of Cuvier (Disciples' Ed., pl. 49, fig. 2) is an exact representation of his new Chilean species. The colour of the specimens from Talcahuano had long since vanished when I described them. Porter, however, has more recently described the living colours of *P. agassizii*, and they seem to conform in the main to the colour scheme of *P. bimaculatus* as described by Philippi:

"El color es en el dorso i flancos del cuerpo bruno-oliváceo, notándose en cada costado del cefalotórax, por detras del surco cervical, una gran mancha triangular de color amarillo limon cuyo vértice redondeado alcanza hasta la aréola, confundiéndose en esta rejion con la del lado opuesto en muchos ejemplares. A veces se vé ademas una mancha redondeada del mismo color a pocos milímetros del borde anterior del carapacho. Los tuberculillos escamiformes de las quelas lo mismo que las espinitas del rostro

son anaranjados, color que se observa en la parte inferior del cuerpo e inferior e interna de las patas. Estas últimas son de color bruno-oliváceo o bien oliváceo, especialmente en las quelas."[1]

With reference to the large triangular colour-patch on each side of the carapace of *P. bimaculatus* as described by Philippi and of *P. agassizii* as described by Porter, it should be observed that spots of the same shape and in the same place are often seen in crayfishes of divers kinds shortly after they are immersed in alcohol. These spots or blotches are the result of the quick action of the alcohol on the thinnest part of the branchiostegites, which are bathed in the fluid on both sides, within and without. At first red, these spots afterwards fade into yellowish white,— the colour which ultimately pervades the whole of the body in specimens preserved in spirits. One is almost inclined to suspect that the colour-pattern noted by Philippi and Porter was due to recent immersion of the specimens in alcohol.

Astacus leniusculus Dana.

A large number of specimens of this species were collected for the U. S. National Museum in Johnson Creek, Portland, Multnomah Co., Oregon, by Messrs. Lyon and Benedict in May, 1905. The largest of these are upwards of five and one half inches long and demonstrate the fact that this species has as full, obese a form as *A. trowbridgii*. There is considerable variation in relative width of the areola in these specimens. Of twenty-six specimens, eighteen (7 ♂, 11 ♀) have the right and left claws symmetrical, while in eight (5 ♂, 3 ♀) the claws are asymmetrical. In many of the asymmetrical individuals I think the smaller, slenderer claw, which may be either on the right or left side, is a new claw grown after the loss of the original one.

In a male specimen collected by Mr. S. E. Meek, in Ten-Mile Lake, Florence, Lane Co., Oregon, Oct. 17, 1896 (U. S. N. M. No. 23,121), the chelae have the form characteristic of *A. leniusculus*, and both pairs of post-orbital spines are developed as in that species, but in the shape of the rostrum and the proportions of the areola it agrees with *A. trowbridgii*. Another specimen in the U. S. National Museum from Astoria, Clatsop Co., Oregon, resembles *A. trowbridgii* in the breadth and inflation of the claws and the length of the posterior section of the carapace. Still another specimen in the same Museum (collected by Mr. Wm. Palmer) from the base of Mt. Tamalpais, Marin Co., Cal., taken altogether would be classed with *A. trowbridgii*; yet in the proportions of the posterior sec-

[1] Porter, op. cit., p. 258.

tion of the carapace and the areola it agrees rather with *A. leniusculus*. As these two species inhabit the same region it is possible that they interbreed and produce hybrids.

Astacus trowbridgii Stimpson.

Astacus trowbridgii stands midway between *A. leniusculus* and *A. klamathensis*. As it varies in one direction towards the former species, as has just been shown, so, on the other hand it passes through intermediate forms into the latter species. Such intermediate forms I have seen from Wilson Creek, Willapa, Pacific Co., and Littlerock, Thurston Co., Washington; and Sinslow River, Mapleton, Lane Co., and Wallowa Lake, Oregon. In dealing with small, immature individuals it is often difficult if not impossible to decide whether they should be assigned to *A. klamathensis* or to *A. trowbridgii*.

Astacus klamathensis Stimpson.

Plate 11, 12.

Astacus klamathensis has a wide distribution in British Columbia, and in the states of Idaho, Washington, Oregon, and northern California, in the vast area drained by the Columbia River and its tributaries as well as in the smaller streams that empty into the Pacific Ocean on the west side of the Cascade Range of mountains.

New localities:—Idaho: Indian Creek, Washington Co. Washington: Goldendale, Klickitat Co.; Granite Lake, Spokane Co.; Naches River, North Yakima, Yakima Co.; Crab Creek, [Douglas Co.?]; Creek near Hemp P. O.; Salmon River; Prairie Creek; North River; Willapa River, Holcomb, Nasel River, Nasel, Pacific Co. Oregon: Wallowa Lake, Wallowa Co.; Silver Creek, Harney Co.; Bear River, Medford, Jackson Co., Johnson Creek, Portland, Multnomah Co.; Nehalem River, Tillamvok Co. California: Shasta River, near Montague, Siskiyou Co.; Cottonwood Creek, near Hornbrook, Siskiyou Co.; Priceland and Garberville, Humboldt Co.

In a lot of two dozen or more specimens of this species from Portland, Oregon, in the U. S. National Museum, a slight variation from the typical form is apparent in the lengthening of the rostrum and antennal scale and the more pronounced granulation of the chelae. In these regards they show a slight approach towards *A. trowbridgii*. Many of these individuals have lost their

claws and grown them anew (see Plate 11, 12). It is interesting to note the restored claws never assume the normal form but are elongated and flattened. When both chelipeds have been lost and re-grown simultaneously, the result is an individual with perfectly symmetrical claws on the right and left sides, so different in shape from the normal claws that one might easily be led to believe that it is a distinct species. Such a specimen is shown in Plate 12, fig. 2. The restored claws in these cases assume an ancestral, less highly specialized from.

Astacus nigrescens fortis, subsp. nov.

Plate 7, Fig. 5, 9; Plate 9, Fig. 2.

Similar to *Astacus nigrescens*, from which it is distinguished by the following characters: — the sides of the rostrum converge more from the base to the tip; the areola of the carapace is narrower in proportion to its length; the chelae are shorter, broader, and more inflated.

Dimensions of a male:— length, 94 mm.; length of carapace, 49 mm.; width of carapace, 26 mm.; length of abdomen, 45 mm.; width of abdomen, 24 mm.; length of posterior section of carapace, 19 mm.; width of areola, 6 mm.; length of chela, 42 mm.; width of chela, 19 mm.; length of dactylus, 22 mm.

Types:— Fall River, Fall City Mills, Shasta Co., Cal., Aug. 29, 1898, Rutter and Chamberlain coll., U. S. N. M., No. 44,404, 2 ♂, 3 ♀, 1 juv.

Paratypes:— Hat Creek, Cassel, Shasta Co., Cal., Aug. 30, 1898, Rutter and Chamberlain coll., U. S. N. M., 3 ♀.

Astacus gambelii connectens, subsp. nov.

Plate 7, Fig. 6, 10; Plate 10, Fig. 1.

Similar to *A. gambelii* (Girard), but different in these regards:— the rostrum is narrower and longer, with a longer acumen, and in correlation with this the antennal scales are much longer, their internal margin sloping gradually to the lengthened apical spine. The post-orbital ridges, though rudimentary, as in *A. gambelii*, develop a pair of prominent posterior spines as in *A. nigrescens*, while the anterior pair — the only post-orbital spines found in *A. gambelii* — are much more prominent than in that form. The chelae are longer and slenderer than in *A. gambelii*.

Types:— U. S. N. M. No. 23,096, Snake River at Upper Salmon Falls, Idaho, Oct. 3, 1894, Evermann and Scovill coll., 3 ♂, 1 ♀.

Paratype:— Silvies River, Burns, Harney Co., Oregon, July 27, 1904, J. O. Snyder coll., 1 ♀. U. S. N. M.

This form bears the same relation to *A. gambelii* as *A. leniusculus* does to *A. trowbridgii*. In the development of the posterior pair of post-orbital spines it shows an affinity to *A. nigrescens*. It appears to be connected with *A. gambelii* by intermediate forms. A large male upwards of $3\frac{1}{4}$ in. long in the U. S. National Museum, collected at the mouth of St. Joe River, Coeur d'Alene Lake, Idaho, has the long narrow rostrum and the elongated hand and fingers of *A. g. connectens*, but the posterior pair of post-orbital spines are wanting, and specimens (also in the U. S. National Museum) from Warm Springs, Harney Co., Oregon, in most respects like typical *A. gambelii*, show traces of the posterior post-orbital spines.

Dimensions of a male:— Length, 65 mm.; length of carapace, 34 mm.; length of abdomen, 31 mm.; length of posterior section of carapace, 11 mm.; width of areola, 5 mm.; length of chela, 31 mm.; breadth of chela, 7.5 mm.; length of dactylus, 18 mm.

Astacus leptodactylus Eschscholtz.

New locality:— Myslowitz, Germany, 1893, Coll. Hofer, (U. S. N. M., No. 43,317) 1 ♂.

Astacus pallipes italicus, subsp. nov.

Plate 8, Fig. 2.

In the Italian Crayfish as compared with the typical form of *A. pallipes* from France, the margins of the rostrum are less convergent from the base to the lateral pair of spines, so that the breadth of the rostrum between the lateral spines is greater; the rostral acumen, too, is longer. The sides of the abdominal segments end in a distinctly more acute angle. The chelae are more coarsely granulated, the granulations or small tubercles separated by wider intervals. The anterior process of the epistoma is more broadly triangular. The antennal scale is larger, longer, and terminates in a more prominent spine. The tip of the inner part of the gonopods of the male is produced beyond the tip of the external part, whereas in *A. pallipes* the tips of the two parts are subequal. The telson is relatively broader.

Types:— U. S. N. M., No. 28,638, River Sarno, Pompeii, Italy, June 10, 1900, Dana Coolidge coll. 11 ♂, 9 ♀.

Two specimens, 1 ♂, 1 ♀, in the U. S. N. M., No. 20,073, from Piobesi, near Turin, Italy, received from the Turin Zoölogical Museum agree in the essential characters with the Pompeiian specimens.

From these specimens I infer that the Cisalpine crayfishes constitute a marked geographical race, which in some respects (viz. the form of the rostrum, antennal scale, epistoma, and gonopods) shows an approach to *Astacus astacus*. It is not, however, liable to be confounded with that species, since the median carina of the rostrum is not denticulated, and the post-orbital ridges are entire, not broken up into an anterior and a posterior section as is the case with *Astacus astacus*. In the important matter of the branchial apparatus, moreover, *Astacus pallipes italicus* differs from *A. astacus* and agrees with *A. pallipes* in having but two rudimentary pleurobranchiae on each side of the body, upon the eleventh and twelfth body-segments.[1]

The crayfish found in the neighbourhood of Madrid, Spain, is in almost every respect like the typical French *Astacus pallipes*. It does, however, show an approach to the Italian examples in one regard, viz. an enlargement of the anterior process of the epistoma, and with this in a few specimens goes a tendency toward a broadening of the rostrum. It would nevertheless be an over-refinement to separate the Spanish crayfishes from *Astacus pallipes*.

Cambarus digueti Bouvier.

Cambarus digueti Bouv., Bull. Mus. d'Hist. Nat., Paris, 1897, **3**, p. 225.
Cambarus carinatus Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 648.

New locality:— Ocotlan, State of Jalisco, Mexico (Field Mus. Nat. Hist.).

Cambarus pilosimanus Ortmann?

A young female crayfish, 35 mm. long (M. C. Z., No. 7,405) was collected by Mr. J. L. Peters at Camp Menzel, 36 miles from the mouth of the Hondo River, in the Territory of Quintana Roo, Mexico, March 27, 1912. It is closely affined to *C. pilosimanus* and *C. williamsoni* of Ortmann, if not identical with one of these. It presents certain features, however, that are not found in either of Ortmann's species; viz: — there are two well-marked spines, one above the

[1] This was determined by examination of the branchial apparatus of two examples from the type lot of *A. p. italicus* from the River Sarno. The rudimentary gills borne on the eleventh and twelfth somites have the form of reduced simple filaments representing the stem of the completely formed gill.

other, on each side of the latero-anterior margin of the carapace, above the well-developed branchiostegian spines. This is a feature that one would not suspect to be a juvenile mark, and it may denote specific diversity. There are, moreover, two sharp spines on the second segment of the antennae near the base of the antennal scales.

The chelae of the specimen collected by Mr. Peters are slender and nearly smooth, the fingers sparsely pilose, the spines of the carpus and merus well developed, as in young specimens of *C. pilosimanus* according to Ortmann. The anterior segment of the telson is three-spined on each side, the inner spine being very small; the median longitudinal rib on the dorsal face of the inner branch of the last abdominal appendages ends in a spine some distance from the posterior margin.

The type locality of *C. pilosimanus* is Coban, Guatemala. Dr. Ortmann also records one specimen, in the Museum of Natural History of Paris, from Belize, British Honduras, a locality not very remote from the place where Mr. Peters got his specimen. Mr. A. S. Pearse (13th Ann. Rep. Mich. Acad. Sci., 1911, p. 110) has more recently recorded it from Cuatotolapam, Canton of Acayucan, State of Vera Cruz, Mexico. The type locality of *C. williamsoni* is Los Amates, Province of Izabal, Guatemala.

Cambarus mexicanus Erichson.

New localities:— Mexico: Tuxtla Gutierrez, State of Chiapas (U. S. N. M., No. 30,580); Jalapa, State of Vera Cruz (Field Mus. Nat. Hist.).

Mr. A. S. Pearse [1] has recently redescribed this species under the name *Cambarus ruthveni*, sp. nov., from the hacienda of Cuatotolapam, Canton of Acayucan, State of Vera Cruz, Mexico, altitude, 15 metres.

Cambarus cubensis Erichson.

New localities:— Cuba: Almendares River, Calabazar, Province of Habana (U. S. N. M., No. 31,881); Unión de Reyes, Province of Matanzas (M. C. Z., No. 7,633); Ciego de Avila, Province of Camagüey (Coll. J. T. Nichols).

There is a small specimen, a male, only $\frac{3}{4}$ in. long, in the U. S. National Museum (No. 28,625), from Nueva Gerona, Isla de Pinos. It was collected by

[1] Report on the Crustacea collected by the University of Michigan — Walker Expedition in the State of Vera Cruz, Mexico. Thirteenth Ann. Rep. Mich. Acad. Sci., 1911, p. 110.

Messrs. Palmer and Riley, July 8, 1900. It may be an immature specimen of one of the races of *C. cubensis*, or possibly a nearly allied species.

Since the above paragraph was written, and the specimen returned to the United States National Museum, Dr. A. E. Ortmann [1] has described as a new species, *Cambarus (Procambarus) atkinsoni*, a crayfish collected by Dr. A. Atkinson in the tributaries of Rio de los Indios, Los Indios, Isle of Pines, May 25, 1910. It is closely related to *C. cubensis*, from which it differs principally in the much less dilated inner face of the copulatory organs of the male.

Cambarus cubensis consobrinus Saussure.

Cambarus consobrinus Sauss., Rev. et Mag. Zool., 1857, sér. 2, **9**, p. 101; Mém. Soc. Phys. Hist. Nat. Genève, 1858, **14**, p. 457, pl. 3, fig. 21.
Cambarus cubensis consobrinus Faxon, Bull. Mus. Comp. Zoöl., Oct. 1912, **54**, p. 458.

In this form of the Cuban Crayfish the rostrum is narrower than in the typical *C. cubensis*, more deeply concave above, its margins more distinctly raised and less convergent between the base and the pair of lateral spines near the distal end; these lateral rostral spines, moreover, are much better developed than in the typical form, and the rostral acumen is longer; the post-orbital ridge is more prominent, distinctly grooved along its outer face, and produced anteriorly into an acute spine much more strongly emphasized than in the typical *C. cubensis;* there is, too, an evident lateral spine on each side of the carapace, on the hind border of the cervical groove,— a spine which is not present in *C. cubensis cubensis*. The external sexual organs are alike in the two forms.

Nine specimens of this crayfish (5 ♂, 4 ♀), M. C. Z., No. 7,343, were secured by Dr. Thomas Barbour from lads who were using them for fish-bait, at San Antonio de los Baños, in the interior of the Province of Habana, Cuba, April, 1909.

Cotypes of Saussure's *Cambarus consobrinus* are now dispersed among the Museums of Geneva, Paris, Berlin, and Washington. It is very likely that Saussure's material included some of the typical form of *C. cubensis*; his description and figures, nevertheless, were grounded on the form with long rostral acumen, and distinct rostral and lateral thoracic spines; the type locality of *consobrinus*, moreover, as specified by Saussure, is the *central part* of the island.

In the cotype in the U. S. National Museum (No. 20,684, *ex Mus. Geneva*),

[1] A New Species of the Genus Cambarus from the Isle of Pines. Ann. Carnegie Mus., May 5, 1913, **8**, p. 414–417.

a male, dried and transfixed with a pin, the rostrum is abnormal, the right margin thereof being pared away toward the tip, carrying with it the right marginal spine. This deformity was evidently present in the living specimen. On the left side the marginal rostral tooth or spine is well developed, as are also the spines at the anterior end of the post-ocular ridges. The lateral thoracic spines too are fairly well marked.

Cambarus cubensis rivalis Faxon.

Cambarus cubensis rivalis Fax., Bull. Mus. Comp. Zoöl., Oct., 1912, **54**, p. 459.

Differs from typical *C. cubensis* (which lives in the low country, near the sea-level) in having a much shorter and broader areola, a shorter, broader, and more heavily granulated claw; the sides of the rostrum, furthermore, are more nearly parallel and they bear a pair of distinct lateral spines at the base of the acumen. In so far as the rostrum is concerned this subspecies resembles *C. c. consobrinus*, yet it differs from *consobrinus* by having a short and wide areola and by the absence of lateral thoracic spines. The sexual parts are like those of *C. cubensis*.

Length of an ovigerous female, 44 mm., length of carapace, 21 mm., length of areola, 6 mm., breadth of areola, 2 mm.

This form is an inhabitant of the mountain streams of western Cuba. The extent of its distribution remains to be determined by further exploration of the island. The type specimens (M. C. Z. No. 7,406), two males of the second form and three females, were caught by Dr. Thomas Barbour in a mountain stream near San Diego de los Baños, in the Province of Pinar del Rio, Feb., 1912. There are also specimens in the U. S. National Museum from the same place (Nos. 28,626, 28,627) and also from a mountain brook north of the town of Pinar del Rio (Nos. 23,656, 23,657).

Cambarus simulans Faxon.

New localities:— Texas: Sourlake, Hardin Co. (U. S. N. M.). Arkansas: Saline R., Benton, Saline Co. (U. S. N. M.). Oklahoma: Mount Scott, Comanche Co. (U. S. N. M.).

Under the name *Cambarus gallinus* this species has been recorded by Messrs. T. D. A. Cockerell and Wilmath Porter (Proc. Acad. Nat. Sci. Phila., 1900, p. 434–435) from the Gallinas River at Las Vegas, San Miguel Co., in lakes at Watrous, Mora Co., and from Roswell, Chaves Co., in the State of New Mexico.

Its range is now known to include the five states, Texas, Arkansas, New Mexico, Oklahoma, and Kansas.

Cambarus gracilis Bundy.

New localities:— Illinois: Abingdon, Knox Co. (U. S. N. M.); Oquawka, Henderson Co. (U. S. N. M.).

Cambarus hagenianus Faxon.

Plate **1**; Plate **7**, Fig. 1, 7.

Cambarus carolinus Hagen, nec Erichson.
Cambarus hagenianus Faxon, Proc. Amer. Acad., 1884, **20**, p. 14.

This species has been hitherto known only through the type specimen in the Museum of Comparative Zoölogy (No. 232), a male of the first form received early in the history of the Museum from Professor Lewis R. Gibbes of Charleston, S. C. The United States National Museum has recently received it in ample numbers from the Agricultural College, Oktibbeha Co., Miss., and also from Muldon, Monroe Co., Miss., and Farmdale, Ala. It is a pest to the cotton growers of these regions, riddling the fields with its burrows, and devouring the young plants; to a less degree it is destructive to young blades of maize or Indian corn.[1]

Hagen's Crayfish attains to a length of three inches. It is nearly related to *C. gracilis* Bundy, replacing that species in more southern localities. In *C. gracilis* the sides of the rostrum are more nearly parallel; the sub-orbital angle, which is pronounced in *C. gracilis*, is wanting in *C. hagenianus*. The branchio-cardiac lines, although contiguous in both *C. gracilis* and *C. hagenianus* for a considerable distance, obliterating the areola, are united for less distance in the former than in the latter; the abdomen is much broader in *C. gracilis*, and the longitudinal rib on the upper side of the inner branch of the last pair of abdominal appendages terminates in a spine which lies some distance from the posterior margin, while in *C. hagenianus* this rib extends clear to the margin, where the spine projects freely. The gonopods of the first form male are formed after a similar fashion in *C. hagenianus*, *C. gracilis*, and *C. simulans;* there are three terminal teeth (one of which is compressed or laminate) in *C. gracilis* and *C.*

[1] See U. S. Depart. Agric., Rept. Bureau Biol. Surv. for 1911, p. 9; and A. K. Fisher, Crawfish as Crop Destroyers, Yearbook U. S. Depart. Agric. for 1911, 1912, p. 319–324, pl. 22.

simulans, but the smallest of the three is smaller in *C. simulans* than in *C. gracilis* and lacks the horny texture; in *C. hagenianus* the truncate end of the gonopods bears but two teeth.

In the second form of the male the gonopods are less perfectly finished at the tips, the terminal teeth being blunter and membranous. The annulus ventralis of the female *C. hagenianus* is much like the annulus of *C. gracilis*, being produced on each side of the median line into a prominent tubercle, each tubercle tending to denticulation.

The specimens from Muldon, Miss., are peculiar in having a beard along the internal border of the upper face of the hand in the males, as in *Cambarus barbatus* and *Astacus gambelii*.

Colour of living specimens from Muldon, Miss.:— Male (Plate 1, fig. 2), metacarapace violet-gray with round greenish spots on the branchial regions; procarapace greenish, dashed with red anteriorly; abdomen light orange, with two longitudinal rows of irregular olive spots; chelae and carpus olive, the tubercles and granules green; fingers and antennae orange, beard whitish. Female (Plate 1, fig. 1), metacarapace bluish; procarapace, abdomen, and chelae tending to green at the expense of the orange tints.

Few cases of colour differences correlated with sex have been noted among Crustacea. See Andrews, Zool. Anz., Apr. 25, 1911, **37**, p. 401.

Cambarus versutus Hagen.

New locality:— Auburn, Lee Co., Alabama (M. C. Z.).

Cambarus blandingii (Harlan).

New localities:— Virginia: Cape Henry, Princess Anne Co. (U. S. N. M.). North Carolina: Mattamuskeet Lake, Hyde Co. (U. S. N. M.); Reedy Fork, Cape Fear River, Greensboro, Guilford Co. South Carolina: Charleston Co. (U. S. N. M.).

Cambarus blandingii acutus (Girard).

New localities:— Illinois: Greathouse Creek, Wabash Co. (U. S. N. M.). Arkansas: Bruce Lake, Little Rock, Pulaski Co. (U. S. N. M.). Maryland: Fulton Co. (U. S. N. M.). Mississippi: Rosedale, Bolivar Co. (U. S. N. M.). Louisiana: Frierson, De Soto Co. (U. S. N. M.). Texas: Angelina River (U. S. N. M.).

A large male, form I., in the U. S. National Museum, collected in 1897 in the Mississippi River at New Orleans, La., measures $5\frac{3}{8}$ in. from the tip of the rostrum to the end of the telson, the chelipeds are $6\frac{7}{8}$ in. long, the chelae $3\frac{3}{4}$ in. long. The dimensions of a male of about the same size were given on page 23 of my Revision of the Astacidae. This specimen also came from New Orleans (M. C. Z., No. 3,327) and is the same one whose measure was given by Dr. Hagen on page 37 of his Monograph of the North American Astacidae with an errour of over an inch in the length.

Cambarus hayi Faxon.

New locality:— Agricultural College, Oktibbeha Co., Mississippi (U. S. N. M.).

Cambarus fallax Hagen.

New localities:— Florida: Auburndale, Polk Co.; Kissimmee River, between L. Hatch and Kissimmee, Osceola Co.; Lake Monroe, near Sanford, Orange Co.; St. Johns R., at Palatka, Putnam Co.; St. Johns River at Beecher Point.

Cambarus acherontis Lönnberg.

New locality:— Eustis, Lake Co., Florida, 2 ♂ f. II., 7 ♀, in U. S. N. M.

Cambarus clarkii Girard.

New localities:— Texas: Fort Clark, Kinney Co.; Seguin, Guadalupe Co.; San Marcos, Hays Co.; Houston, Harris Co.; Corpus Christi, Nueces Co.; Angelina River; Beaumont, Jefferson Co. Louisiana: Lake Lepourde, Morgan City, Saint Mary Co.; Melville, Saint Landry Co.; Frierson, De Soto Co. Arkansas: Little Rock, Pulaski Co., (1 ♀ coll. by O. P. Hay, U. S. N. M., No. 19,762). All of the above are in the U. S. National Museum.

As noted in my Revision of the Astacidae, p. 26, specimens of *C. clarkii* from New Orleans, La., differ slightly from the typical specimens from western Texas in having the branchio-cardiac lines in close apposition for a long distance through the procarapace, obliterating the areola and reducing the size of the anterior and posterior triangular fields. This is well shown in Roetter's beautiful drawing of a specimen from New Orleans in Hagen's Monograph of the North American Astacidae, Pl. 4.

Cambarus clarkii paeninsulanus, subsp. nov.

The examples of Clark's crayfish found in the peninsular portion of the State of Florida differ slightly, albeit constantly, from the typical Texas form in being smoother, in having a more tapering rostrum, and a shorter and broader antennal scale; there is moreover a slight difference in the shape of the tip of the male sexual appendages: the anterior terminal tooth being narrower and more acute than in the typical form in which this tooth is broader, more laminate and less acute at the tip; in the Floridan subspecies, too, the anterior half of the telson bears on each side from three to five spines, while in the typical *C. clarkii* there are but two spines on each side.

Type: M. C. Z., No. 3,530, 1 ♂ f. II. Three miles below Horse Landing, St. John's River, Florida, Feb. 9, 1869, J. A. Allen.

There are a good many specimens of this subspecies in the U. S. National Museum collected by W. C. Kendall at Beecher's Point, St. John's River, Fla., in February and March, 1897, Nos. 28,587, 28,589.

Cambarus wiegmanni Erichson.

This species is still imperfectly known; Erichson's type, which came from Mexico, is no longer extant; it was described as having hooks on both the third and fourth pairs of legs in the male. A female individual from Mexico, in the collection of the Academy of Natural Sciences of Philadelphia, was referred to this species by Dr. Hagen and myself, although with some doubt on account of the want of male specimens. In 1906 Dr. Ortmann (Proc. Washington Acad. Sci., 8, p. 15–19) described and assigned to this species a male belonging to the Philadelphia Academy, collected by Professor E. D. Cope in 1885 in Lake Xochimilco, south of the City of Mexico, in the Federal District; in this specimen the legs of the third pair are furnished with a very small tubercle only, while those of the fourth pair are armed with a strongly developed hook.

Four specimens, three male, one female, recently collected by Mr. W. M. Mann at San Miguel, State of Hidalgo, Mexico, and now in the Museum of Comparative Zoölogy, conform to Ortmann's description of the Cope specimens, barring the fact that there is no vestige of even a tubercle on the third pair of legs of the male, the fourth pair alone being provided with hooks; these specimens may represent an undescribed species, but on account of the sad dearth of requisite material and the loss of the type of *C. wiegmanni* the elucidation of this question must needs be deferred to a later time.

Cambarus viae-viridis, sp. nov.

Plate 5.

Male, form I: — Rostrum long, triangular, plane above, margins raised so as to form a sharp rim, destitute of lateral spines or angles; acumen strongly deflexed, not clearly defined; a shallow depression or foveola at the posterior end of the rostrum. Carapace punctate above, finely granulate on the sides; post-orbital ridges terminating bluntly before; cervical groove sinuate, interrupted on each side; no lateral spine, branchiostegian spine minute; areola narrow, equal in length to about one half the distance from the cervical groove to the tip of the rostrum. Abdomen punctate, pleural angles rounded off, hind border of anterior section of the telson bispinose on each side. Anterior process of the epistome triangular, with slightly convex sides. Antennal scale short and very broad, truncate at the anterior end. Chelipeds of moderate length; upper margin of the meros serrated, below there are two series of spines; carpus tuberculate and spinulose on the inner face; chela of moderate proportions, with slender fingers; superior margin of the hand spinulose, outer and inner faces spinuloso-tuberculate; dactylus spinulose through the proximal quarter of the superior border. Basal segment of last pair of thoracic appendages provided with a crest which is produced on the inner side into a projecting tooth. Third segment of third and fourth pairs of legs hooked. First pair of abdominal appendages rather short, tip truncate, outer part furnished with a prominent horny tooth and two minor denticles, inner part terminating in a straight spine, the end of which does not reach to end of the largest tooth of the outer part.

Length 45 mm., carapace 23 mm., areola 7.5 mm., width of areola 5 mm. Length of hand 17.5 mm. Length of palm 8 mm., width of palm 5.5 mm. Length of fingers 9.5 mm.

Annulus ventralis of the female transversely broad, with a deep sigmoid sulcus which is open in front.

St. Francis River, Greenway, Clay Co., Arkansas, Aug. 1894, S. E. Meek coll. M. C. Z., No. 7,336, 10 specimens, ♂ and ♀.

This species is allied to *Cambarus evermanni* Fax. from Pensacola, Fla. It differs in having the upper surface of the rostrum flatter, with depressed acumen, the areola narrower, the hand broader, and also by the different character of the tips of the male appendages. It falls into the group of species represented by *C. evermanni* Fax., *C. barbatus* Fax., *C. wiegmanni* Erichs., *C. hinei* Ortm., and *C. alleni* Fax.

Cambarus alleni Faxon.

New localities:—Florida: Fort Florida, Volusia Co. (M. C. Z.); ponds near Tampa, Hillsboro Co. (U. S. N. M.); Lake Butler, Tarpon Springs, Hillsboro Co. (U. S. N. M.); Lake Yohopekalize, Kissimmee, Osceola Co. (U. S. N. M.).

Cambarus shufeldtii Faxon.

There is a male of this species, 21 mm. long, in the U. S. National Museum, collected by Robert Kennicott at Cairo, Ill. It has been previously known only from the original type lot collected near New Orleans, La., by Dr. R. W. Shufeldt in 1883.

Cambarus montezumae Saussure.

New locality:— Acambaro, State of Guanahuato, Mexico (Field Mus. Nat. Hist.).

Cambarus montezumae dugesii Faxon.

New localities:— Mexico: Chalco, State of Mexico; Celaya, State of Guanahuato; Lake Quitzeo, Huingo, State of Michoacan; La Barca and Lagos, State of Jalisco; all of these are in the Field Museum of Natural History; they were collected by Prof. S. E. Meek in 1901.

Cambarus montezumae chapalanus Faxon.

New localities:— Patzcuaro and Zirahuen, State of Michoacan, Mexico (Field Mus. Nat. Hist.).

Cambarus montezumae occidentalis Faxon.

Two males, collected by Prof. S. E. Meek, in Lake Quitzeo, Huingo, State of Michoacan, Mexico, and now deposited in the Field Museum of Natural History, appear to belong to this subspecies. It has been already recorded from the same place by Dr. A. E. Ortmann (Proc. Washington Acad. Sci., 1906, 8, p. 20).

Cambarus sloanii Bundy.

Four specimens, males of the second form, collected by Mr. W. P. Hay between Paoli and Wyandotte, Ind. (U. S. N. M., No. 19,776), and determined by Mr. Hay as *C. sloanii*, differ in some important regards from the types of *C. sloanii* from New Albany, Ind.: The tip of the inner ramus of the gonopods is not deflected inward so strongly, the rostrum is longer, with a longer acumen, the large claws are distinctly narrower, with relatively longer fingers, and the outer row of spines on the lower face of the merus of the cheliped is reduced to a single terminal spine. These specimens perhaps represent a new species or subspecies, but in the absence of the first form of the male and the female I refrain from naming it.

Cambarus affinis (Say).

New localities:—Maryland: Sam's Creek, Frederick Co. (U. S. N. M.); Little Pipe Creek at Union Bridge and near New Windsor, Carroll Co. (U. S. N. M.); Northwest Branch near Hyattsville, Prince Georges Co. (U. S. N. M.). Virginia: Orkney Springs, Shenandoah Co. (U. S. N. M.). Massachusetts: Bancroft's Pond, Brown's Pond and Spring Pond, Peabody, Essex Co. (M. C. Z.); Mansfield Pond, Great Barrington, Berkshire Co. (M. C. Z.);

This species, whose real home is in the rivers that flow into the Atlantic in New Jersey, Pennsylvania, Maryland and Virginia, is now well established in the town of Peabody, Essex Co., Mass. How or when it got there I do not know. The first report of it came to me in 1901 when the late J. H. Sears brought me a specimen 90 mm. long, which he had caught in Bancroft's Pond, Peabody, on the 4th of August of that year. In Sept., 1911, Dr. John C. Phillips secured a good many (43) specimens from Spring Pond, Brown's Pond and Bancroft's Pond in Peabody, some of them attaining a length of 98 mm.[1] Dr. Phillips's collector searched for crayfishes in the following ponds in Essex County with negative results:— Hood's, Stephens, Four-Mile, Stiles's, Spofford's and Perley Pond in Boxford, and Chebacco, Beck's, Round and Gravelly Ponds in Hamilton.

On the 14th of June, 1912, I captured a female *C. affinis*, with young under her abdomen, in Mansfield Pond, Great Barrington, Berkshire Co., Mass.

[1] The largest specimen of *C. affinis* in the Museum of Comparative Zoölogy, a female from Havre de Grace, Md., No. 180, collected in 1854, measures 124 mm. from the tip of the rostrum to the end of the telson. This is the individual figured, slightly lengthened, on Plate 5 of Hagen's Monograph of the North American Astacidae.

I was told in Great Barrington that these animals were introduced 10–15 years ago into Lake Buel, on the borders of the neighboring towns of Monterey and New Marlborough, by anglers who were using them as fish-bait, that they are now exceedingly numerous in Lake Buel and have been probably transferred thence to neighboring ponds by boys.

C. affinis has been introduced into Europe as a piscicultural experiment in acclimatization at the Station Agricole at Fécamp, France,[1] and elsewhere.

This species has also been found of late in Central Park Lake, New York City, and in Prospect Park Lake, Brooklyn; it has also been reported as introduced into a lake in East Hampton, Middlesex Co., Conn. (Bull. N. Y. Zoöl. Soc., Nov. 1912, **16**, p. 924).

Cambarus propinquus Girard.

New localities:—New York: Munnsville, Madison Co.; Glennmark Creek, North Rose, Wayne Co.; Chaumont River, Batavia, Genesee Co.; Seneca Lake; Mud Creek and Saint Lawrence River, Cape Vincent, Jefferson Co.; Griffin's Creek, Chaumont, Jefferson Co.; Stony Island, Jefferson Co.; Stony Creek, Henderson Harbor, Jefferson Co.; Sandy Creek, North Hamlin, Monroe Co.; Nine-Mile Point, Webster, Monroe Co.; Selkirk, Oswego Co.; Marsh Creek, Point Breeze, Orleans Co.; Tonawanda Creek; Canada Way Creek, Dunkirk, Chautauqua Co.; Van Buren Point, Chautauqua Co.; Silver Creek, Chautauqua Co.; Cattaraugus Creek. Ohio: Cowles Creek, Geneva, Ashtabula Co.; Conneaut Creek, Kingsville, Ashtabula Co.; Rocky River, Olmsted Falls, Cuyahoga Co.; Port Clinton, Ottawa Co.; Catawba Island, Ottawa Co.; Lakeside, Ottawa Co. Indiana: Tippecanoe River, Delong, Fulton Co.; Sims, Grant Co.; Winona Lake, Kosciusko Co.; Eagle Lake, Warsaw, Kosciusko Co.; Evansville, Vanderburg Co.; Eel River and Blue River, Columbia City, Whitley Co. Illinois: Wabash R., Hutsonville, Crawford Co. (Mus. Comp. Zoöl.); Kankakee River, Momence, Kankakee Co.; Illinois River, Havana, Mason Co. Michigan: Raisin River, Monroe, Monroe Co.; Black Creek, Lexington, Sanilac Co.; Port Sanilac, Sanilac Co.; Grand River below Lansing, Ingham Co.; Wolf Lake, Jackson Co.; Long Lake, 8 miles north of Alpena, Alpena Co.; Tawas City, Iosco Co.; Au Sable River, Au Sable, Iosco Co.; mouth of Carp River, 12 miles from Straits of Mackinac; Mullet Lake, Cheboygan Co. (U. S. N. M.). Mexico: Jimenez, State of Chihuahua (Field Mus. Nat. Hist.).

The locality Jimenez, Mexico, is such an extraordinary one for this species

[1] Acclimatation des Écrevisses Américaines. Revue Scientifique, Jan. 9, 1897, ser. 4, **7**, p. 56.

that one might well suspect some error if the origin of the specimens were not so well-attested. Seven specimens, males of the first form, now in the Field Museum of Natural History, were collected by Mr. S. E. Meek, together with four female *C. virilis*, June 9, 1901, in the drainage of the Rio de los Conchos, one of the southern tributaries of the Rio Grande. They were picked out from among the fishes which were the chief object of Mr. Meek's exploration of Mexico and sent to me for determination in January, 1902.

The conditions obtaining at the time and place of their capture are thus described by Mr. Meek in his account of the fishes secured during his Mexican explorations of 1901:[1]

"At Jimenez the Rio Conchos was nearly dry. Our collections were made from a few deep holes about two miles below the city. These contained a large amount of aquatic vegetation, which made collecting difficult and unsatisfactory. The water was very clear, and in the deeper places were seen many large suckers which we were unable to capture. Sunfishes were very abundant. All of these streams become large and deep in the rainy season, at which time the Rio Conchos at Jiminez becomes two hundred or more feet in width and as much as fifteen feet in depth."

Cambarus propinquus sanbornii Faxon.

New localities:— Ohio: Black River, Elyria, Lorain Co.; Hudson, Summit Co.; Vermilion River; Cuyahoga River, Kent, Portage Co.; Dover Creek, Dover, Cuyahoga Co. West Virginia: Horse Creek (U. S. N. M.).

Cambarus obscurus Hagen.

New localities:— New York: Cattaraugus Creek. West Virginia: Cassity, Randolph Co.; Cheat River, Ises Ferry, Sand Run, Childer's Run, and Trubie's Run, near Buckhannon, Upshur Co.; Queens, Upshur Co.; Weston, Lewis Co.; Hacker's Creek, near Janelew, Lewis Co.; Ten-Mile Creek at Lumberport, Harrison Co.; Decker's Creek above Morgantown, Monongalia Co. (U. S. N. M.).

Cambarus obscurus is an abundant river species in the Upper Ohio River Basin in northern West Virginia, and western Pennyslvania. It is also found in the Lake Erie and Lake Ontario drainage in the states of Pennsylvania and western New York, and in Wills Creek, an affluent of the Potomac River, at Hyndman, Bedford Co., Pa., and Ellerslie, Allegany Co., Md.[2] In the U. S.

[1] A Contribution to the Ichthyology of Mexico. Field Columbian Museum, Publ. 65, Zoöl. Ser., May, 1902, **3**, p. 65.

[2] Ortmann, Mem. Carnegie Mus., 1906, **2**, p. 445.

National Museum there is a female crayfish (No. 22,518) collected by D. S. Jordan in northern Wisconsin which looks like this species, but the locality is an extraordinary one for this species and should not be accepted as authentic until confirmed by securing more material.

Cambarus rusticus Girard.

New localities:— Iowa: West Fork of Des Moines River, Spring Vale, Humboldt Co. (M. C. Z.). Ohio: Sandusky River, Fremont, Sandusky Co.; Presque Isle, Perrysburg, Wood Co. Indiana: Moot's Creek, White Co.; Salmonie River, Mount Etna, Huntington Co. Kentucky: Salt River. Tennessee: Richland Creek, Nashville, Davidson Co. (U. S. N. M.).

Cambarus neglectus Faxon.

New localities:— Missouri: Indian Creek, McDonald Co. (U. S. N. M.). Colorado: Republican River, Wray, Yuma Co. (M. C. Z.).

Cambarus spinosus gulielmi, subsp. nov.

Cambarus spinosus Hay, Proc. U. S. Nat. Mus., 1902, **25**, p. 439 (*nec* Bundy).

Cephalothorax shorter than the abdomen, densely punctate above, granulate on the sides, the granules largest on the hepatic region where they assume the form of small tubercles; the whole surface, but more particularly the sides, is clothed with fine setae arising as pencils from the pits of the dorsal surface and the granules of the sides; the rostrum is deeply excavated above, its sides parallel from the base to the lateral pair of teeth at the base of the moderately long, triangular apex; the post-orbital ridges are prominent and provided with a small tooth at the anterior end; the sub-orbital angle is obliterated, but there is a well-developed branchiostegian spine, as well as a lateral spine on the cervical groove; the section of the carapace behind the cervical groove in the median dorsal line is a little less than one half the distance from the cervical groove to the tip of the rostrum. Areola of moderate width. The anterior segment of the telson bears two spines on each side. The anterior process of the epistome is moderately broad, its sides convex, its anterior angle rounded off. The antennal flagella are long and slender, — longer than the body; the scale or scaphocerite is of moderate width, widest at a point a little anterior to the middle. The chelae, like the carapace, bear numerous setae springing from the pits and

tubercles on its surface; the inner border of the hand is furnished with squamoid tubercles disposed for the most in two longitudinal rows; along the distal half of the outer border of the hand there runs a low, but well-marked, carina; the dactylus is tuberculate on its free border, blunt-toothed (like the immobile finger) along its prehensile edge and ridged longitudinally along its outer face; the carpus is armed with an acute spine on the middle of its internal border, and with a small tubercle at each end of the same border; below, the median carpal spine is well pronounced and there is a small acute spine at the inferior point of articulation with the propodus; the two customary spines are present near the anterior end of the upper margin of the merus; the outer of the two rows of spines on the lower face of the merus is reduced to two at the distal end. The dorsal carina of the inner branch of the last abdominal appendages terminates in a tooth a little distance within the hind margin.

The gonopods, in the second form of the male, are long and straight, reaching forward, when the abdomen is flexed, as far as the basal segments of the second pair of legs; their rami are rather thick, blunt at the tip, and the outer one is but a trifle longer than the inner one; when viewed from the inner side the two rami are fused up to within a short distance of the end of the organ.

The annulus ventralis of the female is bituberculate in front, unituberculate behind, the anterior and posterior walls being separated by a transverse fossa which is divided longitudinally by the sigmoid fissure.

Dimensions of a female:— length, 73 mm., length of carapace, 37 mm., length of rostrum from tip to a level with the post-orbital spines, 11 mm., width of rostrum at base, 5 mm., length of areola, 12 mm., width of areola, 2 mm., length of cheliped, 54.5 mm., length of chela, 27.5 mm., breadth of chela, 12 mm., length of dactylus, 16 mm.

This crayfish is closely related to the *Cambarus spinosus* of Bundy, but is different in the following respects:— the body is more villous, the metacarapace longer in proportion to the procarapace, the anterior process of the epistome is much narrower than in the types of Bundy's species and (what has most weight in regarding it as a subspecies) the external sexual organs are clearly different. The gonopods in *C. s. gulielmi* being shorter, the rami thicker, blunter, nearly equal in length, and separate for but a short distance from the tip, while in *C. spinosus* the rami are slender, pointed, the outer one exceeding the inner by a great distance and the split between the two parts involving a large part of the length of the organ. The annulus ventralis of the female, though of the same type as that of the typical *C. spinosus*, differs slightly in having a more open transverse fossa.

The villosity may be an evanescent character, as it is a condition often apparent in individuals that have recently undergone a moult; at a later period the setae are apt to disappear by attrition.

U. S. National Museum, Nos. 26,379, 12 ♂ f. II., 14 ♀. From a small stream flowing from a pond fed by the cave stream known as John Ross Spring, near Rossville, Walker Co., Georgia, Aug. 23, 1901, William Perry Hay coll.

Cambarus putnami Faxon.

Upward of one hundred specimens of a crayfish closely resembling *C. putnami* were collected by Mr. W. P. Hay in southwestern West Virginia in the summer of 1900. They were found in the shallower parts of streams, usually under flat stones,— in Barrenshe Creek, near Perryville, U. S. N. M., No. 25,018, 28,613, and Horsepen Creek, (U. S. N. M. No. 28,612) and War Creek (U. S. N. M. No. 28,614). In these specimens the rami of the gonopods are a trifle longer than in the types of *C. putnami* from Kentucky, the rostrum, moreover, shows a pretty constant faint carina on its upper surface, near the tip, and the anterior angle of the epistome is truncate. These peculiarities do not seem to me important enough to separate this form nominally from *C. putnami*.

According to Mr. Hay's notes their colour when alive was olive-green on the dorsal surface of the body and chelipeds, changing to vinaceous on the sides, under parts and other appendages; the tips of the fingers were horn-yellow and preceded by a rather broad band of dark orange-red.

Cambarus longidigitus Faxon.

New locality:— James River, Springfield, Green Co., Missouri (U. S. N. M. No. 20,856).

James River, Missouri, without further specification of locality, is the type locality of *Cambarus whitmani* Steele,[1] which as far as can be seen from the description is the same as *C. longidigitus*.

Cambarus virilis Hagen.

New localities:— Indiana: Prairie Creek, Scotland, Green Co. Illinois: Henderson Co.; Kankakee River, Momence, Kankakee Co. Michigan: Belle Isle, Detroit, Wayne Co.; Pigeon River, Caseville, Huron Co.; Bird Creek, Port

[1] Univ. Cincinnati Bull. No. 10, 1902, p. 24.

Austin, Huron Co.; Sand Beach, Huron Co.; Pinnebog River, Port Crescent, Huron Co.; Mud Creek, Bay Port, Huron Co.; Black River, near Port Huron, Saint Clair Co.; Pine River, West Harrisville, Alcona Co.; Au Sable River, Au Sable, Iosco Co.; Rabbit's Back Creek, 5 miles above Saint Ignace, Mackinac Co.; 12 miles from Straits of Mackinac. MINNESOTA: Deer River, Itasca Co.; Lake of the Woods. NORTH DAKOTA: Borit's Ford, Cheyenne River. NEBRASKA: Lincoln Creek, York, York Co. MISSOURI: Clinton, Henry Co. (U. S. N. M.). COLORADO: Republican River, Wray, Yuma Co. (M. C. Z.). MEXICO: Jimenez, State of Chihuahua (Field Mus. Nat. Hist.).

The Mexican specimens (four females) were collected by Mr. S. E. Meek from deep holes, Rio de los Conchos, about two miles below Jimenez, June 9, 1901. For the circumstances of their capture, see under *Cambarus propinquus*, page 373, 374.

CAMBARUS IMMUNIS Hagen.

Plate 2, 6.

New localities:— NEBRASKA: Norfolk, Madison Co. (U. S. N. M.); Elkhorn River, Fremont, Dodge Co. (U. S. N. M.); Omaha, Douglas Co. (M. C. Z.). MISSOURI: Lake City, Jackson Co. (M. C. Z.). IOWA: West Fork of Des Moines River, Spring Vale, Humboldt Co. (M. C. Z.). MICHIGAN: Pine River near West Harrisville, Alcona Co. (U. S. N. M.); Caseville, Huron Co. (U. S. N. M.); mouth of Bunce River, south of Port Huron, St. Clair Co. (U. S. N. M.). ILLINOIS: Wabash Co. (U. S. N. M.); Indian Creek, Abingdon, Knox Co. (U. S. N. M.); Illinois River, Havana, Mason Co. (U. S. N. M.). OHIO: Cedar Point, and Presque Isle, Toledo, Lucas Co. (U. S. N. M.); Toussaint River, ten miles below Port Clinton, Ottawa Co. (U. S. N. M.). NEW YORK: Pond near the mouth of Cattaraugus Creek, Chautauqua Co. (U. S. N. M.); Silver Creek, Chautauqua Co. (U. S. N. M.); Fish Creek, Buffalo, Erie Co. (U. S. N. M.); Stony Island, Jefferson Co. (U. S. N. M.). MASSACHUSETTS: Pontoosuc Lake, Lanesborough, Berkshire Co. (M. C. Z.); Onota Lake, Goodrich Pond and Housatonic River, Pittsfield, Berkshire Co. (M. C. Z.); East Washacum Pond, Sterling, Worcester Co. (M. C. Z.); Blackstone River, Uxbridge, Worcester Co. (M. C. Z.); Lake Boone, Stow, Middlesex Co. (Boston Soc. Nat. Hist.); Walden Pond, Concord, Middlesex Co. (M. C. Z.). NEW HAMPSHIRE: Lake Winnepesaukee (U. S. N. M.).

Cambarus immunis, taken as a whole, has an enormous range, as a common species, through the western states, from northern Ohio, through Indiana,

Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, Kansas and Nebraska, into Colorado and Wyoming.[1] To the eastward of Lorain County, Ohio, it has hitherto been recorded from only two localities, both in the state of New York: in 1891 Mr. Gerrit Smith Miller, Jr., brought me three specimens which he found in July of that year in a small stream flowing into Oneida Lake; these were recorded by me in 1898 (Proc. U. S. Nat. Mus., **20**, p. 654); in 1906 Dr. Ortmann (Mem. Carnegie Mus., **2**, p. 467) called attention to specimens in the New York State Museum which had been taken by Mr. F. C. Paulmier in Rensselaer Lake, Rensselaer Co., N. Y. I can now add to the New York stations for this species the following:— pond near the mouth of Cattaraugus Creek, and Silver Creek, Chautauqua Co. (U. S. N. M. Nos. 22,417, 22,408); Fish Creek, Buffalo, Erie Co. (U. S. N. M. No. 22,418); and Stony Island, at the eastern end of Lake Ontario, Jefferson Co. (U. S. N. M. No. 22,409).

My first knowledge of this species as an inhabitant of Massachusetts was obtained when I was walking across the mud-flats at the upper end of Pontoosuc Lake on the 11th of November, 1899. The numerous mud-towers or "chimneys" here rising above the level of the flat at once betrayed the abode of some kind of burrowing crayfish. Although the soil was then frozen so as to make exploration difficult, I satisfied myself that the builders of the little mud-towers had withdrawn to their brumal retreats in the deeper waters of the Lake, leaving behind them only one dead companion, a first-form male *C. immunis spinirostris* (M. C. Z. No. 6,687). Here the matter rested until, during a visit to Berkshire in 1911, I ascertained that this crayfish was abundant on the 12th of August among the water-weeds at the head of Pontoosuc Lake. Two days later I searched for it at the northern end of Onota Lake in Pittsfield and again found it in altogether similar surroundings, albeit in much smaller numbers than in the neighbouring Pontoosuc or Lanesborough Pond.

On the 15th of June, 1912, I again collected this crayfish at the outlet of Goodrich's Pond and in the Housatonic River just above Pomeroy's Mills, in Pittsfield.

These specimens from Berkshire Co., Mass., agree in most respects with the types of *C. immunis spinirostris*, which were collected in Obion County, Tennessee. The rostrum in the Massachusetts examples tapers a little more between the base and the ante-apical teeth and, the antennal scales are a little shorter in proportion to the length of the rostrum. Compared with the typical

[1] There are two specimens of *C. immunis*, ♂ f. II. and ♀, in the U. S. National Museum, No. 3,257, labelled as coming from Orizaba, Mexico, through Professor Sumichrast.

form of *C. immunis* from Illinois, *C. immunis spinirostris* differs in having a distinct spine or tooth on each side of the rostrum near the tip, more prominent post-orbital and branchiostegian spines and a shorter posterior section of the carapace in relation to the section in front of the cervical groove (the proportion being 1:2 or even less in *C. i. spinirostris*); the claw, too, is narrower, with proportionally longer and slenderer fingers.

In full-grown living specimens from Pontoosuc Lake (Plate 2, fig. 2) the dominant colour of the carapace is a rich Vandyke brown shading into tawny olive on the sides; the cardiac area is conspicuously marked off by being a much lighter colour,— tawny olive; the abdomen is beautifully mottled above with darker and lighter shades of tawny olive; the legs are olive-coloured.

In the young, 27 mm. long, from the same locality (Plate 2, fig. 1), the brown of the adult is replaced by an olive-green which pervades the whole dorsal side of the creature and is delicately varied by mottling of olive-buff; the cardiac area is of the latter hue and is continued backward, through the whole length of the abdomen, as a broad median band; the appendages are delicate olive-green, changing to a pinkish tint at the tips of the claws.

C. i. spinirostris was first described from Obion County, Tennessee; it has also been recorded from Omaha, Nebraska (Pearse), Shawnee County, Kansas (Faxon), Douglas County, Kansas (Harris), Vigo County, Indiana (W. P. Hay), Ottawa Co., Ohio (Pearse), and Long Point Creek, Canada (Pearse). As a matter of fact, specimens of *C. immunis* agreeing more or less closely with the form which I described as var. *spinirostris* are to be found pretty much throughout the range of the species. I have seen such among material collected in Nebraska, Kansas, Missouri, Michigan, Illinois, Indiana, Ohio, and New York. I am therefore disposed to regard it as a variety rather than a true geographical race or subspecies, although it is true that all of the Massachusetts specimens possess the characters of *spinirostris*.

When *Cambarus immunis* was first discovered in Berkshire County, Mass., it had been recorded from only one place (Oneida Lake, N. Y.) east of Lorain County, Ohio, and in the State of Ohio it had been recorded from but three localities — Huron River at Huron, Erie County (Osburn and Williamson, 6th Ann. Rept. Ohio State Acad., 1898, p. 11), Sandusky, Erie County (Faxon, Proc. U. S. Nat. Mus., 1898, 20, p. 654), and Lake Erie, Lorain Co. (Osburn and Williamson, *l. c.*). I was therefore formerly inclined to think that its presence in Berkshire County, Mass., was due to artificial introduction, like the *Cambarus affinis* in the ponds of Essex County, Mass.; but I have now before me specimens from

along the Ohio shore of Lake Erie from Lucas County, through Ottawa County, to Erie and Lorain Counties, from the New York borders of the same Lake in Chautauqua and Erie Counties, from the eastern end of Lake Ontario and from Lake Oneida; while Ortmann's discovery of the specimens in the Albany Museum from Renssalaer County, N. Y., extends the eastward distribution of this crayfish up to Berkshire County, Mass. In the light of all the evidence now collected it seems to me possible, if not probable, that Berkshire County is the eastern limit of the natural distribution of this species and that the discontinuity results from imperfect exploration of the waters of New York State. It should be noted however, for what it is worth, that the Berkshire countrymen whom I have questioned believe the crayfishes are a comparatively late addition to the fauna of the Lakes.

However this may be, there can be no reasonable doubt that the presence of this crayfish in Worcester and Middlesex Counties, Mass., and in Lake Winnepesaukee, N. H., is the result of artificial transference at a comparatively recent date. The first time this animal was found in Walden Pond, Concord, Middlesex County, Mass., so far as I can learn, was in the summer of 1909, when two or more were captured, as I am told by Mr. Reginald Heber Howe, Jr., of the Middlesex School, Concord. In 1910 Mr. Howe sent me a fine specimen, a male about $3\frac{3}{8}$ inches long, which had been taken in the Pond, and in early October, 1911, the Rev. Smith Owen Dexter and Mr. H. Richardson of Concord secured two specimens by a long search under the stones on the edge of Walden. Mr. Dexter's specimen, taken from the Pond the 9th of October, when about $1\frac{1}{2}$ inches long, lived in my aquarium until April 6, 1912, casting its shell twice, on February 20 and March 19, and attaining a length of $1\frac{3}{4}$ inches. On the 14th of June, 1912, Mr. Dexter collected four specimens, ranging from $2\frac{1}{2}$ to $4\frac{1}{2}$ inches in length, from the borders of the Pond, and still more during the following month. On the 24th of July, 1912, Mr. W. F. Clapp and I got six specimens there.

I have been told by citizens of Concord that two men who fished in Walden Pond about ten years ago (*c.* 1903), using crayfishes for bait, threw their surplus bait into the Pond and thus unwittingly stocked it with these creatures.

Walden Pond is apparently a most uncongenial abode for *Cambarus immunis*, being clear as a well and almost destitute of vegetable growth. The favourite haunts of this species are rather muddy waters stocked with a rank growth of pond weeds.

In 1913 specimens of this crayfish were collected in Boone Pond, Stow,

Middlesex County, Mass., by Professor G. H. Barton. Boone Pond drains into the Assabet River. Walden Pond has no visible inlet or outlet.

Dr. D. L. Belding, of the Mass. Fish Commission, collected several specimens in East Washacum Pond, Sterling, Worcester Co., Mass. (Nashua River drainage), Oct. 10, 1912; Mr. W. F. Clapp found many in the Blackstone River, at Uxbridge, Worcester County, Mass., Sept. 29, 1913, and there is a specimen in the United States National Museum collected in 1913 in Lake Winnepesaukee, N. H.

In colour as well as in all other characters the Walden Pond and Blackstone River specimens agree perfectly with those from Berkshire County. Those from Boone Pond, Sterling, and Lake Winnepesaukee I have seen only after they had been immersed in alcohol and lost their colour; in other respects they too are conformable to the Berkshire County variety, *i. e., C. i. spinirostris.*

Cambarus validus, sp., nov.

Plate 7, Fig. 3, 4, 8; Plate 13, Fig. 1.

Male, form I.— Similar to *C. immunis* Hag., but differs as follows:— the rostrum is relatively narrower, less tapering from the base to the lateral angles at the proximal end of the acumen, its margins are more distinctly raised so that the upper surface of the rostrum appears to be more deeply hollowed out. The foveola at the base of the rostrum in *C. immunis* is scarcely evident in *C. validus.* The chela is very much larger, more powerful and of a different form from that of *C. immunis;* the immovable finger is curved strongly outward at the base, giving a convex outline to the external margin of the hand; the movable finger is furnished with a double row of tubercles running along its external margin, while the inner margin is not excised at the base and is armed with a row of eight or nine round bead-like tubercles; the chela is as long as the carapace, and broad and inflated. The lower face of the carpus is furnished with only a rudimentary, blunt, median spine or tubercle. The sub-orbital angle is less prominent, the posterior wall of the orbit forming a perpendicular straight line. The anterior process of the epistome is much broader, with the anterior end truncated but not notched. In other regards, including the form of the sexual appendages it agrees with *C. immunis.* The rostrum is devoid of lateral teeth or spines, like the typical form of *C. immunis.*

Length, 68 mm.; length of carapace, 33.5 mm.; length from tip of rostrum

to cervical groove, 22 mm.; length of chela, 35 mm.; breadth of chela, 15 mm.; length of dactylus, 21.5 mm.

Huntsville, Madison Co., Alabama. One male, form I. M. C. Z., No. 301.

This specimen was considered to be *C. immunis* by Hagen, is mentioned by him on page 72 of his Monograph, and its chela is probably the one figured by him on Pl. VIII, fig. b. Compare my "Revision of the Astacidae," p. 100.

Six specimens in the U. S. National Museum, three of which are males of the second form, and three females (No. 23,092) collected by Mr. J. E. Benedict at Nashville, Tennessee, in May, 1897, without much doubt are conspecific with the type specimen of *C. validus*. As they are younger than the type specimen, and as the first form of the male is not represented among them, the peculiarities of the species are not so well pronounced. The chelae are proportionally smaller and the curve of the immobile finger is less. This finger, as in the type specimen and in *C. immunis*, is heavily bearded within at the base. The gonopods of the males are similar to those of second-form males of *C. immunis*, but less strongly curved; indeed the curve of the stem of the organ is no greater than it is in *C. virilis*, but the blunt recurved tips are subequal as in *C. immunis;* in other words the shape of the second form male organ is the same as in *C. alabamensis*. The annulus ventralis of the female is virtually the same as in *C. immunis*.

Cambarus mississippiensis Faxon.

New locality:— Agricultural College, Oktibbeha Co., Mississippi (U. S. N. M.).

Cambarus lancifer Hagen.

A female specimen, collected by Robert Kennicott at Cairo, Ill., is in the U. S. National Museum. The few specimens heretofore known have come from Root Pond, Miss., Vicksburg, Miss., and the St. Francis River at Greenway and Big Bay, Clay Co., Ark.

Cambarus bartonii (Fabricius).

New localities:— Maine: Little Madawoska River, a tributary of Aroostook River at New Sweden, Aroostook Co. (M. C. Z.); brook tributary to Aroostook River at Caribou, Aroostook Co. (Coll. W. P. Hay). New York: Schoharie Creek, Catskill Mts., Green Co. alt. 2,000 ft. (U. S. N. M.); Little

Simonds's Pond, Franklin Co. (M. C. Z.); Three-Mile Creek, Oswego, Oswego Co. (U. S. N. M.). VIRGINIA: Broad Run and Gap Run, Fauquier Co. (U. S. N. M.); Orkney Springs, Shenandoah Co. (U. S. N. M.); Stony Man Mt., 3000 ft., Madison Co. (U. S. N. M.); Peaks of Otter, 2600 ft., Bedford Co. (U. S. N. M.). WEST VIRGINIA: West Branch of Potomac River, 5 miles west of Circleville, Pendleton Co. (U. S. N. M.); Rich Creek, Spanishburg, Mercer Co. (U. S. N. M.); Trubie's Run, 7 miles above Buckhannon, Upshur Co. (U. S. N. M.). NORTH CAROLINA: Looking-Glass Creek, Transylvania Co., 3300 ft. (U. S. N. M.); near Montreat, Buncombe Co. (U. S. N. M.). TENNESSEE: 7 miles northwest of Chattanooga, Hamilton Co. (U. S. N. M.); Little River, a tributary of the Tennessee River at Cade's Cave (U. S. N. M.).

The Barton's Crayfish of Aroostook County in Northern Maine (of which there is a large collection in the United States National Museum from the Allegash River a little below Chamberlain Lake, Churchill Lake, Eagle or Heron Lake, Crosslake Throughfare, and Bean Lake, St. Francis River) is a small, clean form that in these clear, cool, northern waters shows a slight differentiation from the typical *C. bartonii* from the Middle States. The rostrum is more strongly decurved and the fingers are narrower and more cylindrical and gape widely at the base. The differences between this form and the type nevertheless do not seem to be great enough or constant enough to warrant a subspecific separation.

CAMBARUS BARTONII CARINIROSTRIS Hay MS., subsp. nov.

"Rostrum of medium length, very broad, nearly plane or slightly excavated above and with a more or less distinct, median, longitudinal carina; acumen short, broad, with concave sides, its tip strongly upturned. Carapace with a spinulose angle below the eye; branchiostegian spine obsolescent; areola of moderate width. Telson bi- or tri-spinose on each side. Antennae, when extended backward, reaching beyond the middle of the abdomen. Chelipeds stout and heavy, chelae broad and strong, heavily punctate above and below; inner margin of hand obscurely serrato-denticulate; fingers usually gaping at the base, strong down curved, pitted in lines, upper surface heavily ribbed. Otherwise essentially the same as typical *C. bartonii*.

"This form, which I regard as a well-marked subspecies, is in typical examples very like *C. bartonii* in general, but different in the following regards:—the carapace is a little more cylindrical, the rostrum broader and flatter, and

always furnished near the tip with a median longitudinal carina. This carina is usually well defined and extends from near the acumen backward to about the middle of the broad flat surface of the rostrum; it is generally followed by an ill-defined and very shallow foveola. In less typical specimens the carina is reduced to a very low, rounded, almost invisible elevation just between the lateral angles of the rostrum, or in some cases is wanting altogether; in such specimens the other characters,— cylindrical carapace and broad, flat rostrum,— will hardly be sufficient to separate them from other closely related subspecies.

"Type, U. S. Nat. Mus. No. 23,962. Gandy Creek, Osceola, Randolph Co., W. Va. W. P. Hay coll., July 12, 1899. Mas, forma secunda.

"This crayfish is abundant in the main stream as well as in the tributaries of the Tygart's Valley and Cheat Rivers in Randolph County, West Virginia. I have collected typical examples from the Tygart's Valley River at Beverly and near Elkins. It is most abundant, however, further east in the Cheat River basin, and Osceola may be regarded as approximately the centre of its distribution."—W. P. Hay MS.

C. b. carinirostris Hay is a slightly differentiated local form of *C. bartonii* found chiefly in the mountain streams of Randolph Co., W. Va., the Cheat and Tygart's Valley Rivers and their tributaries. Outside of Randolph County, Mr. Hay secured a few specimens at Albright, Preston Co., at Queens, Upshur Co., in the above-named river-basins. It is also probably to be found in the upper waters of the Kanawha River basin further to the south, since there are a few specimens in the U. S. National Museum (Nos. 23,975, 28,605) from the West Fork of the Greenbrier River, near Durbin, Pocahontas Co., and from Laurel Creek, in second Water Cave, near Greenville, Monroe Co., that are pretty characteristic examples of this race.

The median carina on the upper surface of the rostrum is a rather elusive character, in many individuals it is scarcely if at all apparent. Such specimens retain, nevertheless the peculiar quadrangular outline of the rostrum, which is often a trifle broader at the base of the acumen than it is in the middle. The areola is of moderate width and not so thickly pitted as it is in *C. b. montanus*.

The dimensions of Mr. Hay's type are as follows:—

Length, 63 mm.; length of carapace, 32 mm.; length of areola, $11\frac{1}{2}$ mm.; width of areola, $2\frac{1}{2}$ mm.; width of rostrum between the eyes, 4 mm.; length of chela, 25 mm.; breadth of chela $11\frac{1}{2}$ mm.; length of dactylus, $16\frac{1}{2}$ mm.

Cambarus bartonii montanus (Girard).

In looking over any extensive collection of *Cambarus bartonii* from the Alleghany Mountain region of Virginia and West Virginia one is struck by the tendency of the material before him to fall into two sets of forms, one characterized by a rather narrow areola, sparsely sown with impressed points or dots which incline to a serial arrangement in three or four longitudinal rows; while in the other set the areola is shorter and proportionally broader, and its field is thickly strewn with innumerable dots. On further examination it will be seen that the narrower areola usually goes with a shorter and broader rostrum, a more depressed and oval carapace and a narrower antennal scale. These two forms are often found in the same locality and with these alone in view one might be justified in deeming them two well-differentiated species, but it soon becomes clear that in other places specimens are found that combine in a most perplexing fashion the features of our two supposed species.

The second of the two forms above noticed, the one with the shorter and broader and more thickly punctate areola and longer rostrum is the one too curtly diagnosed by Girard under the name of *Cambarus montanus*.

Girard's description of *C. montanus* is as follows:— "Antennæ more elongated and more filiform than in *C. Bartonii*. Rostrum intermediate in shape between the latter and *C. carolinus*, being proportionally longer than in *C. Bartonii* and shorter and less tapering than in *C. carolinus*. Dorsal sutures of the carapace more apart than in both of the latter species.

"*Localities.*— Within the Alleghany ranges in Virginia and Maryland: tributaries of James River in Rockbridge Co. (Va.); Shenandoah River in Clarke Co. (Va.), and Cumberland (Md.) of the hydrographical basin of the Potomac; Sulphur Spring, Greenbrier River, an affluent of the Kenhawa River (Va.) [now W. Va.] of the Ohio basin."

When Dr. Hagen was preparing his Monograph of the North American Astacidae in 1868, he had the opportunity to examine one of Girard's types of *C. montanus* from Greenbrier River, W. Va., sent to him by Wm. Stimpson who then had the types from the Smithsonian Institute in Chicago, where in 1871 they were most unfortunately destroyed by the disastrous conflagration of that year.

Sixteen years later, while I was revising the Astacidae, I had the advantage of close personal intercourse with Dr. Hagen and free use of his notes and memoranda. The identity of Girard's *Cambarus montanus* is thus assured by an unbroken tradition. Neither Dr. Hagen nor myself in my earlier publications esteemed this form worthy of even a subspecific name, although its characters

were pointed out in my Revision, p. 64. It may be well in our present more advanced knowledge of the *C. bartonii* group to recognize *C. montanus* as a geographical race or subspecies of *C. bartonii*.

In the collection of the Academy of Natural Sciences of Philadelphia there is a young male, labelled "James River, Va., *C. montanus?*" which is very probably a cotype or paratype of Girard's *Cambarus montanus*. With regard to this and other *quasi* types of Girard's species in the Philadelphia Academy, the reader is referred to Hagen's Monograph, p. 7, and my Revision, p. 11.

I have examined specimens of *C. bartonii montanus*, nearly or quite typical, from the following localities:—VIRGINIA: Wytheville, Wythe Co. (U. S. N. M., No. 13,966, M. C. Z., No. 3,838); Rocky Gap, Bland Co. (U. S. N. M., No. 28,568.) WEST VIRGINIA: Horsepen Creek, [Mingo Co.?] (U. S. N. M. No. 28,555); Madam Creek, tributary of New River, opposite Hinton, Summers Co. (U. S. N. M., No. 28,556, M. C. Z., No. 7,398); Bergen's Springs, 12 miles above Hinton (U. S. N. M., No. 28,566); Delashmeet Creek, Kegley, Mercer Co. (U. S. N. M., No. 28,610); Bluestone River, just above its mouth, Mercer Co. (U. S. N. M., No. 28,570); mouth of Delashmeet Creek, Bluestone River, Mercer Co. (U. S. N. M., No. 28,565); Bluestone River, Abb's Valley (U. S. N. M., No. 28,569); East River, Mercer Co. (U. S. N. M.); Rich Creek, Spanishburg, Mercer Co. (U. S. N. M.); Barrenche Creek, Perrysville, McDowell Co. (U. S. N. M., No. 28,573); War Creek, McDowell Co. (U. S. N. M., Nos. 28,564, 28,580); Guyandotte River, Baileysville, Wyoming Co. (U. S. N. M., Nos. 28,562, 28,578, 28 ♂).

Isolated localities from which I have seen specimens of *C. bartonii* very closely resembling the form *montanus* in the breadth and punctation of the areola are: Alum Creek, Franklin Co., Ohio, R. C. Osburn and E. B. Williamson (U. S. N. M., No. 22,351), Cincinnati, Ohio (M. C. Z., No. 288), creek at Knoxville, Tenn., Walter Faxon (M. C. Z., No. 3,477). From Cogar's Mill, Elk River, Kanawha Co., W. Va., I have seen an interesting lot of specimens that combine the characters of *C. b. montanus* and *C. b. longulus*, the rostrum and chela of *montanus* going with the reduced sub-orbital angle of *longulus*. These specimens are in the U. S. National Museum, No. 23,990, and in the Museum of Comparative Zoölogy, No. 7,401.

CAMBARUS BARTONII ROBUSTUS (Girard).

Plate 3.

From *Cambarus bartonii montanus* the passage is easy to *C. b. robustus*, in which form the rostrum is longer and more tapering, the areola rather longer and narrower and the outer margin of the hand more costate, an emphatic de-

pression running along the upper and lower faces of the immobile finger. In the United States National Museum there are many specimens from West Fork of Greenbrier River, W. Va. (No. 23,977, 23,978) and from Crane Creek, W. Va., which are very nearly typical examples of *C. b. robustus*. They differ slightly, it is true, from more northern specimens in having a little broader areola and less pronounced impressions upon the immobile finger. In these regards they show an approach to *C. b. montanus*, from which the form *robustus* is probably derived.

Specimens collected at Wytheville, Wythe Co., Va. (U. S. N. M., No. 13,966, M. C. Z., No. 3,838) which were referred to *C. b. robustus* by me in 1890 (Proc. U. S. Nat. Mus., 12, 622) are in reality *C. b. montanus*.

Examples from Fredericksburg, Spotsylvania Co., Va., were formerly referred to *C. robustus* by Hagen in his Monograph, p. 80, and by myself in my Revision, p. 61, 67, but they are not typical examples of *C. robustus*. These specimens (M. C. Z., Nos. 3,615, 3,797) are in many ways like to *C. acuminatus* in the rostrum which is longer and more tapering than in *robustus*, in the relatively short posterior section of the carapace, greater width of the areola, and the highly developed spines at the base of the antennal scales, on the carpus, and on the merus. The lateral spine of the carapace is distinctly developed on almost all of the Fredericksburg specimens. A similar form is found at Raleigh, N. C. (U. S. N. M. No. 22,355).

After eliminating the specimens which have been wrongly identified with *C. robustus*, the distribution of the latter race, in its true form, is restricted, as far as known, to the following regions:—Ontario: Toronto, Weston. Michigan: Wayne, Washtenaw, Oakland, Sanilac, Huron, Oscoda, Crawford, Alcona and Ionia Counties. Ohio: Knox, Lorain, Cuyahoga, and Ashtabula Counties. New York: Chautauqua, Genesee, Allegany, Monroe, Wayne, Tompkins, Oswego, Madison, Jefferson, St. Lawrence, Herkimer and Hamilton Counties. Pennsylvania: Erie, Crawford, Warren, McKean, and Allegheny Counties (St. Lawrence and Upper Ohio drainage). West Virginia: West Fork of Greenbrier River and Crane Creek.

Cambarus bartonii robustus is a sombre-coloured crayfish in life (Plate 3), the dominant color of the upper surface being a dusky olive tone, nearly uniform and little relieved by the inconspicuously red-tipped fingers of the large claw. The ambulatory appendages have a somewhat bluish cast, and the ventral surface of the creature tends to a dull whitish tint. After the animal is placed in alcohol, a large, bright red, quadrangular patch presently appears on the branchiostegites behind the cervical groove, denoting that part of the shell which

is most susceptible to the action of the liquid. After some hours the red colour extends over the whole branchial region and for a time is sharply defined from the median areola and the other parts of the body, which still retain the dusky colour of the living animal. These striking colour-patterns resulting from recent immersion in alcohol might easily be mistaken for natural life colours by one who had not witnessed the change, and it suggests the probability that some writers have been misled into describing such colours as those of the living animal. Randall, for instance, in the Journal of the Academy of Natural Sciences of Philadelphia, **8**, p. 138, Pl. 7, describes and figures *Astacus oreganus* (= *A. leniusculus* Dana?) as having a red spot on each side of the carapace, quite similar to the red spot which temporarily shows in *Cambarus b. robustus* recently immersed in alcohol. So, too, the whitish or lemon-yellow spot on the branchiostegites of *Parastacus bimaculatus* Philippi (Anales Universidad Chile, **87**, p. 378), which is probably the same species that I described under the name *Parastacus agassizii* (*cf.* the colour description of this species by Prof. Carlos E. Porter in Revista Chilena de Historia Natural, **8**, p. 258, pl. 9, fig. b) may possibly be the result of the action of alcohol on freshly killed specimens.

Cambarus bartonii longulus (Girard).

New localities:— West Virginia: West Fork of Greenbrier River, near Durbin, Pocahontas Co. (U. S. N. M., No. 23,992); Bluestone River, Abb's Valley (U. S. N. M., No. 28,618).

In normal specimens of this subspecies the sub-orbital angle is hardly if at all prominent. The individuals which I mentioned in Proc. U. S. N. M., **12**, p. 623, as having the orbit sharply defined below by a prominent angle may prove to be, I suspect, *C. bartonii longirostris*. This form is not very well known as yet, and I have reason to think that it acquires with maturity a claw very much like that of *C. bartonii longulus*. The character of the sub-orbital margin of the carapace seems to be very constant within the limits of a good subspecies, and it may prove to be the really diagnostic feature for separating *C. b. longulus* and *C. b. longirostris*.

Cambarus bartonii veteranus, subsp. nov.

Plate **13**, Fig. 2.

Rostrum long, without lateral teeth, margins elevated, strongly convergent, acumen triangular, terminating in an upturned corneous tooth. Antero-lateral

margins of the carapace destitute of any marked angle below the eye. A small spine on each side of the carapace on the posterior edge of the cervical groove. Areola long and broad, $\frac{1}{4}$ as broad as long, thickly strewn with impressed dots. Anterior process of the epistome triangular, truncated anteriorly in old individuals. Chelae large, flattened, internal border furnished with a row of low tubercles, with another row of obsolescent ones running along beside them. The outer margin of the chela is ridged, on account of a marked longitudinal depression which runs along the distal part of the palm and the proximal part of the immobile finger. The fingers are long, heavily pitted, meeting only at their tips, leaving a wide gape between them. The carpus is armed with an internal median spine, and a very small internal posterior spine; below it is furnished with the usual anterior median spine and a minute spinous tubercle between it and the internal median spine. The lower face of the merus is armed with a row of spines along its internal margin and an incomplete row on its external margin made up of about three at the distal end of the joint.

Length of a ♂ form I., 93 mm.; length of carapace 49 mm.; length of areola, 17 mm.; width of areola, 4 mm.; length of chela, 67 mm.; width of chela, $26\frac{1}{2}$ mm.; length of dactylus, 45 mm.

Type locality, Indian Creek, Baileysville, Wyoming Co., W. Va.

Two males of the first form, sixteen males of the second form and seven females were collected by Mr. W. P. Hay at this place on the 16th of August, 1900. They are in the collection of the U. S. National Museum, Nos. 25,020, 28,609, 44,712 (type).

There are also in the National Museum one male of the second form and two females (No. 28,619) from Crane Creek, W. Va., collected together with *C. b. robustus* on the 8th of August, 1900, and one male of the first form from the Elk River, Cogar's Mills, W. Va.

This peculiar form of *C. bartonii* resembles *C. b. longulus* in the form of the rostrum, the wide gape of the fingers of the large claw, and in the absence of a sub-orbital angle. In other respects it is very different from *longulus*, especially in the shape of the chela which is strongly depressed, with deep longitudinal furrows at the base of the immovable finger, both above and below, as in *C. b. robustus*, while in *C. b. longulus* the fingers are cylindrical and bearded within at the base. The characteristic gape of the fingers is not present in regenerated claws, which are furnished with very long straight fingers whose cutting edges are straight and meet together throughout their whole length.

Cambarus bartonii asperimanus, subsp. nov.

Even as these pages are going to press, two specimens of a peculiar, new race of *C. bartonii* are sent to me from the U. S. National Museum,— males of the first form, collected by Messrs. P. C. Standley and H. C. Bolman in Flat Creek, near Montreat, Buncombe Co., N. C., Sept. 1, 1913. *C. bartonii bartonii* was also collected at the same time and place. The new form is conspicuously different from any previously known race of *C. bartonii* in having scattered coarse setae upon the chelae, which are moreover deeply and coarsely pitted, with a tendency toward corrugation; the inner border of the propodus is furnished with a cristiform row of from five to seven teeth; the dorsal face of the carapace is extremely smooth and shows hardly a trace of the customary pits or impressed dots except a row along the margin of the rostrum; even on the areola the dots are scarcely visible without high magnification; finally, the anterior process of the epistoma is broadly truncate in front.

Such are the diagnostic characters of this sub-species, which in other regards agrees pretty closely with typical *C. bartonii*. The hooks of the third segment of the third pair of legs are acute and attenuated at the tip.

Length, 54 mm., carapace, 27 mm.; chela, 19 mm. Type, U. S. N. M., No. 47,375.

Cambarus bartonii acuminatus Faxon.

Cambarus acuminatus Faxon, Proc. Amer. Acad., 1884, **20**, p. 113.

New localities:— Maryland: Northwest Branch, Hyattsville, Prince George's Co. (U. S. N. M.); Indian Creek, Beltsville Prince George's Co. (U. S. N. M.); North Carolina: Halifax, Halifax Co. (U. S. N. M.).

As noted above under *Cambarus bartonii robustus*, specimens from Fredericksburg, Va. (M. C. Z., Nos. 3,615, 3,797) approach closely to the form *acuminatus* and seem to exemplify a transition from *robustus* to *acuminatus*.

Cambarus bartonii laevis, subsp. nov.

This form of *C. bartonii* differs from the typical race in having the carapace smoother and less conspicuously punctated, the posterior section proportionately longer, being equal in length to the distance from the cervical groove to the root of the eye-stalks; this lengthening of the hind section of the carapace involves a long areola which is also not merely relatively but also absolutely

narrower than in the typical *C. bartonii;* the areola is so narrow as to allow barely room for two closely approximated longitudinal rows of dots; the rostrum is a little longer than in *C. bartonii*, with more convergent margins and a longer acumen; the upper or superior border of the hand and movable finger are more distinctly tuberculate; the fingers are shorter, stronger, and more heavily ribbed, and the outer border of the immobile one is more heavily and coarsely punctate. The posterior internal spine of the carpus is obsolete; the anterior process of the epistoma is more broadly triangular.

Type specimen, M. C. Z., No. 3,812, W. S. Blatchley, Bloomington, Ind. ♂, form II. Measurements:— Length, 67 mm., length of carapace, 33 mm., length of areola, 14 mm., breadth of areola at middle, 1 mm., length of right chela, 24 mm., length of right dactylus, 16 mm.

Other localities:— Fall Creek, Indianapolis, Ind. (M. C. Z., No. 3,796), New Albany, Ind. (M. C. Z., No. 3,618), Irvington, Ind. (U. S. N. M., Nos. 19,738, 22,204), May's Cave, Monroe Co., Ind. (U. S. N. M., No. 19,740).

The peculiarities of this crayfish, which appears to be a common form in the State of Indiana, were first pointed out in my Notes on North American Crayfishes, Proc. U. S. Nat. Mus., 1890, **12**, p. 622. It has been described and figured, as *C. bartonii*, by Mr. W. P. Hay in the Twentieth Ann. Rep. of the Department of Geology and Natural Resources of Indiana, 1896, p. 437–489. The features which distinguish it from the typical form of *C. bartonii* are so pronounced as to render it necessary to mark it as a subspecies of *C. bartonii* if not as a valid species. In the great relative length of the posterior section of the carapace it resembles *C. bartonii tenebrosus* Hay from the Mammoth Cave of Kentucky.

According to letters which I received from Dr. John Sloan of New Albany, Ind., in the year 1883, this crayfish was always found by him in that region to be a denizen of standing ponds and still water, being replaced by *C. sloanii* in the running streams. On the contrary, both Mr. W. P. Hay (*l. c.*, p. 489) and Mr. A. M. Banta (The Fauna of Mayfield's Cave, Carnegie Inst. of Washington, Publ. No. 67, Sept. 1907, p. 73–75) aver that it is most commonly found in springs and small streams of clear running water where it seeks concealment under stones or in shallow burrows.

Messrs. Hay and Banta have found this form a frequent inhabitant of the caves of southern Indiana in company with the blind species, *C. pellucidus.* Those that dwell in the caves appear to attain a greater size than those in the surface waters, specimens in the Mitchell Caves, Lawrence Co., often exceeding

100 mm. in length according to Banta, while those from the outside do not exceed 84 mm. A series of fifty-eight specimens from the outside waters compared with a series of six specimens from Mayfield's Cave, Monroe Co., by Mr. Banta revealed the fact that the antennae of the cave specimens averaged 11.89 p. c. longer than the antennae of specimens taken outside the caves in the immediate vicinity. The cave series was also lighter-coloured than the series from above ground.

Cambarus graysoni, sp. nov.

Cephalothorax robust, posterior section high, flattened on the back and compressed laterally so that the sides are nearly vertical, giving to the whole section a subquadrangular aspect; shell densely punctated on the dorsal face, granulated on the lateral surfaces; distance from the tip of the rostrum to the cervical groove one and one half times the length from the cervical groove to the posterior end of the carapace; there are no lateral spines upon the carapace and only the rudiments of the branchiostegal spines; the areola is narrow (1.5 mm. broad at the middle in a specimen measuring 21 mm. from the cervical groove to the posterior border of the carapace) with but two rows of dots along the narrow part of its course; rostrum short, margins slightly convergent, middle excavated, acumen short, upturned at the tip, without lateral spines or teeth; post-orbital ridges low, without spines; sub-orbital angles well marked but blunt.

Abdomen as long as the cephalothorax, smooth, pleural angles rounded.

Chelipeds short in proportion to the body; merus short, with low tubercles near the distal end of the superior margin and spines biserially arranged on the lower face; carpus deeply furrowed along the upper face, armed with a prominent median internal acute thorn or spine, one or two small tubercles in place of a median posterior spine; an inferior median spine, with sometimes a small tubercle between it and the interior median spine completes the armature of the carpus; the chela is short, broad and triangular, articulated with the carpus in such a way as to assume a vertical position when flexed and to form with its fellow a shield or operculum appressed to the front of the body; this conformation of the chelae is a sure token of the burrowing habits of this species; the inner (or superior) margin of the palm, is very short, with a marginal row of five or six low tubercles; immediately within this row (which forms a serrate edge to the hand) is another row of similar though smaller tubercles, with vestiges of a few more irregularly disposed near the articulation of the dactylus; the fingers

are rather short, strongly curved downward or inward, not conspicuously ribbed, their prehensile margins armed with rounded teeth, the free edge of the dactylus furnished with low, ciliated, squamous tubercles.

Antennal scale small, narrow. Anterior process of the epistome broad, truncate, anterior border concave, with a median tooth. Sexual organs of male and female similar to those of *C. bartonii*.

Dimensions of a female specimen:— length, 113 mm. length of cephalothorax, 54 mm., breadth, 29 mm., height of do., 21 mm.; length of areola, 21 mm., breadth of areola, 1.5 mm.; length of cheliped, 75 mm.; merus, 21 mm.; length of chela, 39 mm.; breadth of chela, 19 mm.; length of dactylus, 24 mm.

Bear Creek, a tributary of Green River, Grayson Springs, Grayson Co., Ky., Oct. 24, 1874, F. W. Putnam coll. 1 male of the second form, 3 females. M. C. Z., No. 3,593.

This species is nearly related to *C. ortmanni*. Its form, like that of *C. ortmanni*, denotes a species of fossorial habits, but not so preëminently addicted to subterranean life as the species of the *C. diogenes* group, in which the cephalothorax suffers a greater lateral compression. Compared with *C. ortmanni*, *C. graysoni* is more depressed dorsally, more heavily punctated, the areola is broader (as broad as in the typical form of *C. latimanus*) the metathorax somewhat shorter in proportion to the prothorax, the suborbital angle is much more salient, the anterior process of the epistoma is deeply emarginate in front, with a prominent spine at the bottom of the emargination, the internal carpal spine is acute even in old and large examples, and the tubercles of the inner (superior) margin of the hand are stronger and biserially disposed.

The specimens which form the types of *C. graysoni* were referred to *C. bartonii* in my Revision of the Astacidae, p. 61, 159, 169. The peculiarities of the chelipeds, however, show that they belong to a distinct species, allied to *C. ortmanni* and *C. latimanus* and forming together with these species a group connecting *C. bartonii* and its near allies with *C. diogenes* and the nearly related preeminently burrowing forms.

Cambarus ortmanni Williamson.

Cambarus ortmanni Williamson, 31st Ann. Rept. Department Geol. Indiana, 1906, 1907, p. 754–760, pl. 35.

Cambarus ortmanni, a burrowing species, was described by Mr. E. B. Williamson from specimens captured in Wells Co., Ind., in the Wabash River drainage near Bluffton. There has been a single female specimen from Cincinnati, O.,

however, in the Museum of Comparative Zoölogy since the early days of the Museum. This specimen, No. 243, was referred to *C. bartonii* by Dr. Hagen in his Monograph and entered into his computation of the variability of the width of the areola of that species, on p. 78. In my subsequent Revision of the Astacidae, in 1885, p. 64, I referred to this individual as possibly a peculiar species related to *C. latimanus*.

In the shape of the body and the narrow areola *C. ortmanni* bears a close resemblance to *C. latimanus striatus*, but in the outline of the rostrum and the sculpture of the claws it betrays a closer resemblance to *C. bartonii*. It is without doubt an immediate offshoot of the latter, modified by fossorial habits; the narrow areola, broad, conical claws, small antennal scale, long, narrow and quadrangular epistome, all denote this. It forms a passage from *C. bartonii* to *C. latimanus* on the one hand and on the other to the more eminently fossorial forms, *C. carolinus*, *C. diogenes*, etc.

Cambarus latimanus (Le Conte).

There is a cotype, a dried male, in the Museum of Comparative Zoölogy, No. 3,378, acquired by exchange of types with the Smithsonian Institution in 1861; another cotype, a dried female, is preserved in the collection of the Academy of Natural Sciences of Philadelphia. There are also in the Museum of Comparative Zoölogy, No. 236, preserved in alcohol, 3 males of the first form, 6 males of the second form, 3 females, and 7 young, collected in Athens, Ga., and sent to Professor Agassiz by LeConte in the 50's. These are essentially paratypes, and are of interest as fixing the type locality, Athens, Ga., which was not specified in Le Conte's original description of the species nor on the labels accompanying the type specimens in Cambridge and Philadelphia.

Two males, dried, M. C. Z., No. 3,366, sent by Prof. Lewis R. Gibbes from South Carolina as *C. bartonii*, without precise locality, are the only specimens reported from South Carolina so far as I know.

A small young female from Milledgeville, Ga. (M. C. Z., No. 3,365) and another from Roswell, Ga. (M. C. Z., No. 3,502) probably belong to this species.

Specimens from Blount Spring and Cullman, Ala. (U. S. N. M., No. 4,953, M. C. Z., No. 3,639) differ from the typical form in having a narrower rostrum, and in specimens from Bridgeport, Ala., and Nickajack Cave, Ashland City, and Nashville, Tenn., the divergence from the type is so pronounced that Mr. W. P. Hay has described them as a subspecies, *C. latimanus striatus* (Proc. U. S. Nat. Mus., 1902, **25**, p. 437; type locality, Nashville, Tenn.).

Mr. C. F. Baker has sent me a fine lot of *C. latimanus* from Auburn, Ala., among them specimens that have attained a length of four inches.

Cambarus carolinus Erichson.

This species was described in 1846 (Arch. Naturgesch., **12**, 1, p. 96). Erichson's type, a male of the first form, is preserved in the Berlin Museum. It was collected by Dr. Cabanis, who assured Dr. Hagen that all the crayfishes that he collected in the United States came from a rivulet in a plantation called Tiger Hall, near Greenville, S. C.[1] In 1902 Mr. W. P. Hay procured from Dr. Johann Thiele of Berlin a photograph of the type specimen together with drawings of the right claw and first and second abdominal appendages. By means of this photograph and the drawings Mr. Hay identified the species with the crayfish which I described in 1884, from Cranberry Summit (now Terra Alta), Preston Co., W. Va., under the anme of *Cambarus dubius* (see Hay, Proc. Biol. Soc. Washington, **15**, March 5, 1902, p. 38.

By the courtesy of Mr. Hay I have before me Dr. Thiele's photograph and drawings of Erichson's type, and find that, although it nearly resembles *C. dubius*, yet it presents some different characters. The carpus is armed on its inner margin with two prominent, acute spines; of these the larger, anterior one is the so-called internal median carpal spine; on the left cheliped the photograph reveals a tubercle just behind, and at a lower level than, the median spine. In *C. dubius* there is but one carpal spine, the internal median. Furthermore, the outer margin of the hand of *C. carolinus*, as shown in Dr. Thiele's drawing, is rounded off and lacks the subserrate ridge characteristic of *C. dubius;* in this regard the hand of *C. carolinus* appears to be like that of *C. monongalensis* Ortm.

No. 14,314, U. S. N. M., male, form I., "among the Cherokees, James Mooney," agrees closely with the pictures of Erichson's type, and may be considered a typical *C. carolinus*. In a notice of this specimen as *C. dubius* in 1890 (Proc. U. S. Nat. Mus., **12**, p. 624), I erred in ascribing it to the Indian Territory. I am advised by Mr. Mooney that it was in reality obtained in Swain Co. or in Jackson Co., N. C., among the *Eastern* Cherokees,— a remnant of the Nation which eluded deportation in 1838 and still clings to the old home in western North

[1] Mr. W. P. Hay (Proc. Biol. Soc. Washington, **15**, p. 38, 1902) has unfortunately given this locality as *western North Carolina*, and has been followed in this error by Mr. J. A. Harris (Kansas Univ. Sci. Bull., 1903, **2**, p. 81, 142, 154).

Carolina.[1] It thus appears that Mr. Mooney's crayfish came from a region not far remote from the type locality of *C. carolinus*.

In this specimen (U. S. N. M., No. 14,314), which displays the normal features of *C. carolinus*, as I believe, the rostrum is narrower than in *C. dubius* and less quadrangular in outline; the anterior process of the epistoma is much broader and more triangular in outline, the sides converging much more between the base and the truncated anterior angle; the carpus is armed with a prominent, acute, internal median spine, immediately behind which and at a little lower level lies a very small spiny tubercle; posteriorly to this, not far from the inner articulation with the merus, lies another distinct spine, smaller than the internal median spine; the lower face of the carpus bears one tubercle about half-way between the internal median spine and the outer articulation with the propodus; the lower face of the merus shows the biserial arrangement of spines as in *C. dubius*, as many as five or six spines adorning the external edge of the segment; the distal segment of the outer branch of the last pair of abdominal appendages is shorter and broader (less oval in contour) than in *C. dubius*. The living color of this specimen, as is shown by a MS. note accompanying the specimen, was red, the color of *C. dubius* also.

A large number of specimens in the U. S. National Museum collected at various places in the southwestern part of West Virginia (Nos. 28,591–28,596, 28,598–28,600, Horsepen Creek, War Creek, Baileysville, Lashmeet, Barranche Creek), agreeing in most respects with the typical *C. dubius* from northern West Virginia and Pennsylvania tend to develop the accessory carpal spines and tubercles of *C. carolinus*.

Three specimens (male, form I.) in the U. S. National Museum, No. 22,386, from a tributary of Stone River twenty miles from Columbia in central Tennessee are interesting. They agree in most respects with *C. c. dubius*, but the rostrum is a little narrower, with more convergent margins, the rostral acumen is less abrupt, and the outer border of the hand is rounded off without much indication of serrature. In these regards the specimens agree with the typical *carolinus;* the carpus, however, is very smooth, bearing no spines except the internal median, as in *C. c. dubius*. The outer inferior row of spines on the merus is present, though slightly developed. The branchio-cardiac lines are in closer contact than in any other specimens of this species that I have seen, reducing the areola to a narrow line.

[1] See Myths of the Cherokee, by James Mooney, Nineteenth Ann. Rept. Bureau Amer. Ethnol. 1897–98, 1900, p. 308.

The closely related Blue or Monongahela Crayfish was first discovered at Pittsburgh, Pa., in 1898, by Mr. E. B. Williamson. Specimens were sent to me in the month of August of that year, which appeared to me to be a local form of *C. dubius*, and they were recorded as such by Mr. Williamson in a paper on the Crayfish of Allegheny County, Pennsylvania (Ann. Carnegie Mus., 1901, 1, p. 11). Compared with the type of *C. dubius* these specimens showed a narrower rostrum with less pronounced angles at the base of the acumen; the outer border of the hand was evenly rounded, not ridged, and destitute of the imperfect serrature seen in *C. dubius*, where this feature results from the regular row of transversely elongated marginal punctations giving to the margin a milled appearance; further, the carpus of the Pittsburgh form was armed with several accessory spines and tubercles, besides the prominent internal median spine which is all the armature of the carpus in *C. dubius*.

In a paper on the Crawfishes of western Pennsylvania published in 1905 (Ann. Carnegie Mus., 3, No. 2) and in a more elaborate memoir which appeared at the close of the following year (The Crawfishes of the State of Pennsylvania, Mem. Carnegie Mus., 2, No. 10), Dr. A. E. Ortmann showed that the Blue Crayfish and *C. dubius* both lived in western Pennsylvania, that they occupied different areas separated by the Chestnut Ridge, a range of hills on the west of the Allegheny Mountains, the Blue Crayfish (to which he gave the name *Cambarus monongalensis*) being found on the hills lying on the west of this range while *C. dubius* lived in the mountain region to the east of Chestnut Ridge, between it and the principal range of the Allegheny Mountains. Dr. Ortmann also brought out clearly, as a result of extensive field study, the color-difference between the two forms, the dominant color of *C. dubius* being red, of *C. monongalensis* blue. The range of the latter form appears to be rather narrow, being restricted, as far as is shown by Dr. Ortmann's most interesting investigations, to Westmoreland, Allegheny, Beaver, Washington, Fayette and Green Counties, Pa., and Hancock, Brooke, Ohio, Marshall and Monongalia Counties, W. Va., at altitudes ranging from 800 feet to 1200 feet above the sea-level.

Dr. Ortmann compared his specimens of *C. monongalensis* with the northern race of *C. carolinus*, *i. e.*, *C. dubius* Fax., and came to the conclusion that they represented a distinct species. But as appears from what has been said above, three of the characters which Ortmann thought were peculiar to *C. monongalensis* are also present in the southern, typical form of *C. carolinus*, viz., the narrower rostrum, non-serrated outer margin of the hand, and the presence of more than one spine on the inner side of the carpus. There are thus left but two features

to separate *C. monongalensis* from *C. carolinus*, viz., the uniserial disposition of the spines on the lower face of the merus of the cheliped, and the colour.

So, with a broader overlook of the geographical variations of these interesting forms it would seem to be more logical to consider *C. carolinus* Erichs., *C. dubius* Fax. and *C. monongalensis* Ortm. as three geographical races, or subspecies of one species. The three subspecies may be distinguished by means of the subjoined key:—

Lower face of merus with only one row of spines developed. Colour, blue		*C. carolinus monongalensis* (Ortm.)
Lower face of merus with two rows of spines developed. Colour, red.	Margins of rostrum distinctly convergent; outer margin of hand rounded, not serrated; more than one spine on inner margin of the hand..	*C. carolinus carolinus* Erichs.
	Rostrum broader with nearly parallel margins; outer margin of hand subserrate; only one spine on inner margin of the hand . .	*C. carolinus dubius* Fax.

The geographical range of *C. c. monongalensis*, so far as it has been worked out by Dr. Ortmann, has been given above. More exploration is needed to elucidate the dispersal of the typical *C. carolinus*. The type locality is near Greenville, Greenville Co., S. C. The specimen in the U. S. National Museum, collected by James Mooney and described above, came from Swain or Jackson Co., western North Carolina. Ortmann (Mem. Carnegie Mus., **2**, p. 397) mentions some specimens in the Academy of Natural Sciences of Philadelphia, collected by Prof. J. P. Moore at Blowing Rock, Watauga Co., N. C., which have a narrower rostrum than *C. c. dubius*, and are therefore probably *C. c. carolinus*.

Specimens collected by Mr. H. G. Hubbard at Pennington's Gap, Lee Co., Va. (M. C. Z., No. 3,489) and by myself at Cumberland Gap, at the junction of the three states of Virginia, Kentucky and Tennessee (M. C. Z., No. 3,594) are too young to determine subspecifically with assurance, but they appear to be *C. c. dubius*. The form spread over the southwestern parts of West Virginia, as has been pointed out (p. 397) is more or less intermediate between *carolinus* and *dubius*, while the pure *C. c. dubius* has been reported from Westmoreland, Fayette, and Somerset Cos., Pa., Garrett Co., Md., and Preston, Tucker, and Mineral Cos., W. Va.

Cambarus diogenes Girard.

New localities:— Maryland: Laurel, Prince Georges Co. (U. S. N. M.). Virginia: Dismal Swamp (U. S. N. M.). North Carolina: Near Beaufort, Carteret Co. (Coll. W. P. Hay). Alabama: Auburn, Lee Co. (M. C. Z.). Mississippi: Muldon, Monroe Co. (U. S. N. M.); Agricultural College, Oktibbeha Co. (U. S. N. M.). Ohio: Toledo, Lucas Co. (U. S. N. M.). Indiana: Near Milltown, Crawford Co. (U. S. N. M.); Lake Maxinkuckee, Marshall Co. (U. S. N. M.); White Co. (U. S. N. M.). Illinois: Wabash Co. (U. S. N. M.); Henderson Co. (U. S. N. M.); near Olney, Richland Co. (U. S. N. M.). Iowa: Burlington, Des Moines Co. (U. S. N. M.). Michigan: Raisin River, Monroe, Monroe Co. (U. S. N. M.). Nebraska: Omaha, Douglas Co. (M. C. Z.); Creighton Creek, south of Niobrara, Knox Co. (U. S. N. M). Colorado: Fort Collins, Lorimer Co. (M. C. Z.).

Knox Co., Indiana, given as a station for *C. diogenes* in my Revision of the Astacidae, page 71, should be transferred to *C. argillicola*, p. 77.

Cambarus diogenes ludovicianus Faxon.

New localities:— Frierson, De Soto Co., La.; Rosedale, Bolivar Co., Miss.; U. S. N. M.).

Cambarus argillicola Faxon.

New localities:— Olney, Richland Co., Ill. (U. S. N. M.); Frierson, De Soto Co., La., in burrows 18 inches deep, surmounted by low mud "chimneys" (U. S. N. M.).

Cambarus uhleri Faxon.

Mr. W. P. Hay captured one specimen of this species near Beaufort, N. C., Aug. 17, 1912. This specimen, a female, was taken from a hole in the bank of a pond on the south side of Adley's Creek, about fourteen miles north of Beaufort. On the other side of the same creek, about a mile away, Mr. Hay collected three specimens of *C. diogenes* (also females) in holes on the edge of a swamp. The specimen of *C. uhleri* differs from the type specimens from Maryland but very slightly, the rostrum being a trifle more concave above, and the foveola at the base of the rostrum rather more pronounced.

Uhler's Crayfish has heretofore been known only from the tidewater Ocean and Bay counties of eastern Maryland.

Cambarus clypeatus Hay.

Proc. U. S. Nat. Mus., Oct. 11, 1899, **22**, p. 122, fig. 2.

The type specimen of this species, a female, U. S. Nat. Mus., No. 17,277, is the only one known. It was found by Mr. G. A. Coleman, of the U. S. Biological Survey, in April, 1892, in a skiff at Bay St. Louis, Miss. Mr. Hay surmises that it belongs in the neighbourhood of *C. cubensis;* I should incline rather, on account of the structure of the annulus ventralis and the shape of the body, to place it in *C. bartonii* group.

LIST OF THE DESCRIBED SPECIES OF CRAYFISHES (PARASTACIDAE AND ASTACIDAE).

PARASTACIDAE.

Astacopsis Huxley.

Astacopsis Huxley, Proc. Zoöl. Soc. London, 1878, p. 764.

1. Astacopsis franklinii.

Astacus franklinii Gray, Eyre's Journals of Expeditions of Discovery into Central Australia, 1845, **1**, p. 409.

Type locality:— Tasmania.

2. Astacopsis nobilis.

Astacoïdes nobilis Dana, Crustacea U. S. Expl. Exped., 1852, **1**, p. 526.

Type locality:— New South Wales?

3. Astacopsis spinifera.

Cancer serratus Shaw, Zoölogy of New Holland, 1794, pl. 8, (nec *Cancer serratus* Forskål, 1775).

?Astacus australasiensis Milne Edwards, Hist. Nat. Crustacés, 1837, **2**, p. 332. *Type locality:*— Sydney, Australia. *Two cotypes*, Paris Mus.

?Astacus australiensis Erichson, Arch. Naturgesch., 1846, **12**, 1, p. 94 (*nom. emend.*).

Astacoïdes spinifer Heller, Reise der Novara, Zool. Th., **2**, pt. 3, Crust., 1865, p. 102.

Astacus armatus Martens, Ann. Mag. Nat. Hist., 1866, ser. 3, **17**, p. 359. *Type locality:*— Murray River, Australia. *Type*, Berlin Mus.

?Astacopsis paramattensis Bate, Rept. Challenger, **24**, Crust. Macrura, 1888, p. 202. *Type locality:*— Paramatta River, Sydney, Australia. *Type*, Brit. Mus., 1 ♀.

?Astacopsis sydneyensis Bate, Rept. Challenger, **24**, Crust. Macrura, 1888, p. 204. *Type locality:*— Sydney, Australia. *Type*, Brit. Mus., 1 ♀.

Type locality:— Australia.

Incertae Sedis.

1. Astacopsis ? tasmanicus.

Astacus tasmanicus Erichson, Arch. Naturgesch., 1846, **12**, 1, p. 94.

Type locality:— Tasmania. *Type*, Berlin Mus., No. 1,579, ♀.

CHERAPS Erichson.

CHERAPS Erichson, Arch. Naturgesch., 1846, **12**, 1, p. 101.

1. CHERAPS PREISSII.

Astacus (Cheraps) preissii Erichson, Arch. Naturgesch., 1846, **12**, 1, p. 101.

?Astacoïdes plebejus Hess, Arch. Naturgesch., 1865, **31**, 1, p. 164. *Type locality:*— Sydney, Australia. *Type*, Göttingen Mus.

Type locality:— Southwestern Australia.

2. CHERAPS BICARINATUS.

Astacus bicarinatus Gray, Eyre's Journals of Expeditions of Discovery into Central Australia, 1845, **1**, p. 410.

Type locality:— Port Essington, North Australia.

3. CHERAPS QUADRICARINATUS.

Astacus quadricarinatus Martens, Monatsber. Akad. Wissensch. Berlin, 1868, p. 617.

Type locality:— Cape York, Australia. *Type*, Berlin Mus., No. 2972.

4. CHERAPS QUINQUECARINATUS.

Astacus quinquecarinatus Gray, Eyre's Journals of Expeditions of Discovery into Central Australia, 1845, **1**, p. 410.

Type locality:— Western Australia, near Swan River.

ENGAEUS Erichson.

ENGAEUS Erichson, Arch. Naturgesch., 1846, **12**, 1, p. 102.

1. ENGAEUS FOSSOR.

Astacus (Engaeus) fossor Erichson, Arch. Naturgesch., 1846, **12**, 1, p. 102.

Type locality:— Tasmania. *Types*, Berlin Mus., Nos. 1123, 1124.

2. ENGAEUS CUNICULARIUS.

Astacus (Engaeus) cunicularius Erichson, Arch. Naturgesch., 1846, **12**, 1, p. 102.

Engaeus cunicularis Haswell, Cat. Australian Stalk- and Sessile-eyed Crustacea, 1882, p. 179. (*Err. typograph.?*)

Type locality:— Tasmania. *Type*, Berlin Mus., No. 1122.

PARANEPHROPS White.

PARANEPHROPS White, Gray's Zoöl. Miscell., June, 1842, p. 79.

1. PARANEPHROPS PLANIFRONS.

Paranephrops planifrons White, Gray's Zoöl. Miscell., June, 1842, p. 79.

?Paranephrops tenuicornis Dana, Crustacea U. S. Explor. Exped., 1852, **1**, p. 527. *Type locality:* — Fresh-water streams about the Bay of Islands, North Island, New Zealand.

Type locality: — River Thames, North Island, New Zealand. *Types*, Brit. Mus.

2. Paranephrops zealandicus.

Astacus zealandicus White, Proc. Zoöl. Soc. London, 1847, part 15, p. 123.

Paranephrops neo-zelanicus Chilton (in part), Trans. and Proc. New Zealand Inst., 1888, **21**, p. 249 (*nom. emend.*).

Type locality: — New Zealand. *Types*, Brit. Mus.

3. Paranephrops setosus.

Paranephrops setosus Hutton (in part), Ann. Mag. Nat. Hist., Nov. 1873, ser. 4, **12**, p. 402.

Paranephrops horridus "S[emper?] MS.," Miers, Cat. Stalk-and Sessile-eyed Crust. New Zealand, 1876, p. 73. (*nom. nudum*). Brit. Mus.

?Astacoïdes tridentatus Wood-Mason, Proc. Asiatic Soc. Bengal, 1876, p. 4. *Type locality:* — New Zealand.

Type locality: — River Avon, near Christchurch, South Island, New Zealand.

Astaconephrops Nobili.

Astaconephrops Nobili, Annali del Mus. Civ. Storia Nat. Genova, 1899, **40**, p. 244.

1. Astaconephrops albertisii.

Astaconephrops albertisii Nobili, Annali del Mus. Civ. Storia Nat. Genova, 1899, **40**, p. 244.

Type locality: — Katau, southern New Guinea. *Type*, Genova Mus., 1 ♀.

Astacoïdes Guérin.

Astacoïdes Guérin, Revue Zoologique, 1839, **2**, p. 109.

1. Astacoïdes madagascariensis.

Astacus madagascariensis Aud. et M. Edw., Journ. de l'Institut, 1839, p. 152.

Astacoïdes goudotii Guérin, Revue Zoologique, 1839, **2**, p. 109. *Type locality:*— Madagascar. *Type*, Acad. Nat. Sci. Philad., Guérin Coll., No. 290.

Astacus caldwelli Bate, Proc. Zoöl. Soc. London, 1865, p. 469. *Type locality:*— Near Antananarivo, Madagascar.

Type locality: — Madagascar.

Parastacus Huxley.

Parastacus Huxley, Proc. Zoöl. Soc. London, 1878, p. 771.

1. Parastacus pilimanus.

Astacus pilimanus Martens, Arch. Naturgesch., 1869, **35**, 1, p. 15.

Type locality: — Porto Alegre, Brazil. *Types*, Berlin Mus., Nos. 3,323, 3,447.

2. Parastacus brasiliensis.

Astacus brasiliensis Martens, Arch. Naturgesch., 1869, **35**, 1, p. 16.

Type locality: — Porto Alegre, Brazil. *Types*, Berlin Mus., Nos. 3,322, 3,448.

3. Parastacus defossus.

Parastacus defossus Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 686.

Type locality: — Montevideo, Uruguay. *Types*, U. S. N. M., No. 19,647; *paratype*, M. C. Z., No. 4,776.

4. Parastacus saffordi.

Parastacus saffordi Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 683.

Type locality: — Montevideo, Uruguay. *Types*, U. S. N. M., No. 12,581; *paratype*, M. C. Z., No. 4,775.

5. Parastacus varicosus.

Parastacus varicosus Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 685.

Type locality: — Colima, Mexico (by error?). *Type*, U. S. N. M., No. 4,133.

6. Parastacus chilensis.

Astacus chilensis M. Edw., Hist. Nat. des Crustacés, 1837, **2**, p. 333.

Type locality: — Coasts of Chile. *Type*, Mus. Hist. Nat. Paris.

7. Parastacus bimaculatus.

Astacus bimaculatus Philippi, Anales Universidad Chile, 1894, **87**, p. 378.

Parastacus agassizii Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 690.

Type locality: — Talcahuano, Chile. *Types*, M. C. Z., No. 3,400; *paratypes*, U. S. N. M., No. 12,045.

Type locality: — Chile.

8. Parastacus spinifrons.

Astacus spinifrons Philippi, Anales Universidad Chile, 1882, **61**.

Type locality: — Chile.

9. Parastacus nicoleti.

Astacus chilensis Nicolet (nec M. Edw.), Gay's Hist. Chile, Zool., 1849, **3**, p. 211. *Type locality:* — Chile.

Astacus nicoleti Philippi, Anales Universidad Chile, 1882, **61**.

Type locality: — Chile.

10. Parastacus hassleri.

Parastacus hassleri Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 687.

Type locality: — Talcahuano, Chile. *Types*, M. C. Z., No. 3,401; *paratypes*, U. S. N. M., No. 19,689.

11. Parastacus araucanius.

Parastacus araucanius Faxon, supra, p. 353.

Type locality: — Corral, Chile. *Type*, M. C. Z., No. 7,355.

Astacus Fabricius.

Astacus Fabricius, Syst. Entomol., 1775, p. 413.

1. Astacus colchicus.

Astacus colchicus Kessler, Bull. Soc. Imp. Moscou, 1876, **50**, p. 2.

Type locality: — Upper Rion River and tributaries, Transcaucasia.

2. Astacus pachypus.

Astacus pachypus Rathke, Mém. Acad. Imp. St. Pétersbourg, 1836, **3**, p. 365.

Astacus caspius Eichwald, Bull. Soc. Imp. Moscou, 1838, p. 149. *Type locality:* — Caspian Sea, near Baku.

Type locality: — Neighborhood of Nikolaiev, Boug River, Russia.

3. Astacus leptodactylus.

Astacus leptodactylus Eschscholtz, Mém. Soc. Imp. Moscou, 1823, **6**, p. 109.

Astacus leptodactylus salinus Nordmann, Observations sur la Faune Pontique, in Demidoff's Voyage dans la Russie Méridionale et la Crimée, Atlas, Crustacea, 1842, Tab. 1. *Type locality:* — Black Sea.

Type locality: — Government of Taurida, Russia.

3a. Astacus leptodactylus caspius.

Astacus leptodactylus, var. *caspia* Eichwald, Bull. Soc. Imp. Moscou, 1838, p. 148.

Type locality: — Caspian Sea, near Lenkoran.

3b. Astacus leptodactylus angulosus.

Astacus angulosus Rathke, Mém. Acad. Imp. St. Pétersbourg, 1836, **3**, p. 364.

Type locality: — Crimea, Russia.

4. Astacus kessleri.

Astacus kessleri Schimkewitsch, Bull. Soc. Imp. Amis Hist. Nat. Moscou, 1886, **50** (Proc. Zool. Sect., **1**, pt. 1, p. 20).

Type locality: — Near the town of Turkestan, Government of Syr-Darya, Asiatic Russia.

5. Astacus astacus.

Cancer astacus Linné, Syst. Nat., Ed. 10, 1758, **1**, p. 631.

Astacus fluviatilis Fabr., Syst. Entomol., 1775, p. 413. *Type locality:* — Europe.

Cancer nobilis Schrank, Fauna Boica, 1803, **3**, 1 Abth., p. 246. *Type locality:* — Bavaria.

Astacus fluviatilis communis Gerstfeldt, Mém. Acad. Imp. St. Pétersbourg, 1859, **9**, p. 554. *Type locality:* — Europe.

Type locality: — Europe.

6. Astacus pallipes.

Astacus pallipes Lereboullet, Mém. Soc. Sci. Nat. Strasbourg, 1858, **5**, p. 7.

Astacus fontinalis Carbonnier, L'Écrevisse, 1869, p. 8. *Type locality:* — France.

Type locality: — In canals and ditches, Strasbourg, Alsace.

6a. Astacus pallipes fulcisianus.

Astacus pallipes, var. *fulcisiana* Ninni, Atti Soc. Ital. Sci. Nat. Milano, 1886, **29**, p. 326.

Type locality: — Province of Belluno, Italy.

6b. Astacus pallipes italicus.

Astacus pallipes italicus Faxon, supra, p. 361.

Type locality: — River Sarno, Pompeii, Italy. *Types*, U. S. N. M., No. 28,638; *paratypes*, M. C. Z., No. 7,409.

7. Astacus torrentium.

Cancer torrentium Schrank, Fauna Boica, 1803, 3, 1 Abth., p. 247.

Astacus saxatilis Koch, Deutschlands Crustaceen, Myriapoden und Arachniden, 1835?, 7, No. 1 (Panzer and Herrich-Schäffer's Deutschlands Insecten, 140, No. 1). *Type locality:* — Bavaria, in mountain brooks of the Oberpfalz and also in the Danube under stones.

Astacus tristis Koch, Deutschlands Crustaceen, Myriapoden und Arach niden, 1835?, 7, No. 2 (Panzer and Herrich-Schäffer's Deutschlands Insecten, 140, No. 2). *Type Locality:* — Bavaria, in a mountain brook at Bodenstein, Regen River system.

Astacus longicornis Lereboullet, Mém. Soc. Sci. Nat. Strasbourg, 1858, 5, p. 2. *Type locality:* — Ill and Bruche Rivers, Alsace.

Type locality: — Bavaria, in stony streams and also in lakes, e. g. Würm-See.

8. Astacus gambelii.

Cambarus gambelii Girard, Proc. Acad. Nat. Sci. Philad., 1852, 6, p. 90.

Type locality: — "California." *Types*, Acad. Nat. Sci. Philad.

8a. Astacus gambelii connectens.

Astacus gambelii connectens Faxon, supra, p. 360.

Type locality: — Snake River, Upper Salmon Falls, Idaho. *Type*, U. S. N. M. No. 23,096; *paratype*, M. C. Z., No. 7,385.

9. Astacus nigrescens.

Astacus nigrescens Stimpson, Proc. Boston Soc. Nat. Hist., Feb., 1857, 6, p. 87.

Type locality: — Neighborhood of San Francisco, Cal. *Types* probably destroyed in the Chicago fire in 1871.

9a. Astacus nigrescens fortis.

Astacus nigrescens fortis Faxon, supra, p. 360.

Type locality: — Fall River, Fall City Mills, Shasta Co., Cal. *Type*, U. S. N. M., No. 44,404; *paratypes*, M. C. Z., No. 7,383.

10. Astacus trowbridgii.

Astacus trowbridgii Stimpson, Proc. Boston Soc. Nat. Hist., Feb., 1857, 6, p. 87.

Type locality: — Columbia River above Astoria, Oregon. *Cotypes*, U. S. N. M., No. 2,080; M. C. Z., No. 3,510; Bost. Soc. Nat. Hist.; Peabody Mus. Yale Univ.

11. Astacus leniusculus.

Astacus leniusculus Dana, Crustacea U. S. Expl. Exped., 1852, **1**, p. 524.

?Astacus oreganus Randall, Journ. Acad. Nat. Sci. Philad., 1840, **8**, p. 138.

Type locality: — Columbia River. *Type* destroyed.

Type locality: — Columbia River and Puget's Sound. *Cotype*, U. S. N. M., No. 2,019, and probably No. 2,161.

12. Astacus klamathensis.

Astacus klamathensis Stimpson, Proc. Boston Soc. Nat. Hist., Feb., 1857, **6**, p. 87.

Type locality: — Klamath Lake, Oregon. *Type* probably destroyed in the Chicago fire in 1871.

CAMBAROÏDES Faxon.

Cambaroïdes Faxon, Proc. Amer. Acad., 1884, **20**, p. 150.

1. Cambaroïdes japonicus.

Astacus japonicus De Haan, Crustacea of Siebold's Fauna Japonica, 1842, p. 164.

Type locality: — Japan.

2. Cambaroïdes similis.

Astacus (Cambaroïdes) similis Koelbel, Anz. Akad. Wissensch. Wien, math.-nat. Classe, 1892, **29**, p. 176; Sitzungsber., 1892, **101**, pt. 1, p. 650.

Type locality: — Province of Kjöng-Kur-do, Korea.

3. Cambaroïdes dauuricus.

Astacus dauuricus Pallas, Spicilegia Zoologica, 1772, Fasc. 9, p. 81.

Astacus leptorrhinus Fischer, Bull. Soc. Imp. Moscou, 1836, **9**, p. 467.

Type locality: — Dauria. *Types*, St. Petersburg Mus.[1]

4. Cambaroïdes schrenckii.

Astacus schrenckii Kessler, Bull. Soc. Imp. Moscou, 1874, **48**, p. 361.

Type locality: — Lower Amur River Basin.

[1] *I. e.*, were there when the species was described.

CAMBARUS Erichson.

CAMBARUS Erichson, Arch. Naturgesch., 1846, **12**, 1, p. 88.

§ I. Third segment of the third pair of legs of the male furnished with hooks. First pair of abdominal appendages of the male stout, inner and outer parts closely appressed, laterally compressed, with a horny (in the first form) spine at the tip; anterior margin with a prominent shoulder near the distal end. (Subgenus PROCAMBARUS of Ortmann.)

1. CAMBARUS DIGUETI.

Cambarus digueti Bouvier, Bull. Mus. Hist. Nat. Paris, 1897, **3**, p. 225.

Cambarus carinatus Faxon, Proc. U. S. N. M., Feb. 17, 1898, **20**, p. 648. *Type locality:* — Guadalajara, Mexico. *Type*, U. S. N. M., No. 17,699, 1 ♂ f. I; *paratypes*, U. S. N. M., No. 16,085 (Ameca, State of Jalisco, Mex.), 17,707 (Hacienda de Villachuato, State of Michoacan, Mex.); M. C. Z., No. 4,338 (Ameca, Mex.).

Type locality: — Affluents of River Santiago, State of Jalisco, Mexico. *Cotypes*, Mus. Hist. Nat. Paris; U. S. N. M., No. 30,579; Carnegie Mus. Pittsburgh.

2. CAMBARUS WILLIAMSONI.

Cambarus (*Procambarus*) *williamsoni* Ortmann, Annals Carnegie Mus., 1905, **3**, p. 439.

Type locality: — Los Amates, Province of Izabal, Guatemala. *Types*, Carnegie Mus. Pittsburgh.

3. CAMBARUS PILOSIMANUS.

Cambarus (*Procambarus*) *pilosimanus* Ortmann, Proc. Washington Acad. Sci., May 3, 1906, **8**, p. 6.

Type locality: — Coche, near Coban, Guatemala. *Types*, Mus. Hist. Nat. Paris; *paratypes*, Carnegie Mus. Pittsburgh (1 ♂ f. I., 1 ♀).

4. CAMBARUS MEXICANUS.

Astacus (*Cambarus*) *mexicanus* Erichson, Arch. Naturgesch., 1846, **12**, 1, p. 99.

Cambarus aztecus Saussure, Rev. et Mag. Zool., 1857, ser. 2, **9**, p. 503. *Type locality:* — Tomatlan [State of Vera Cruz?] Mexico. *Cotypes*, Geneva Mus.; U. S. N. M., No. 20,682 (1 ♂ ex Geneva Mus.).

Cambarus ruthveni Pearse, 13th Rept. Mich. Acad. Sci., 1911, p. 110. *Type locality:* — Cuatotolapam, Canton of Acayucan, State of Vera Cruz, Mexico. *Types*, Mus. Univ. Michigan, No. 41,704, 41,705, 1 ♂, 1 ♀.

Type locality: — Mexico. *Type* seemingly lost from the Berlin Mus.

5. Cambarus cubensis.

Astacus (*Cambarus*) *cubensis* Erichson, Arch. Naturgesch., 1846, **12**, 1, p. 100.

Type locality: — Cuba. *Type,* Berlin Mus.

5a. Cambarus cubensis consobrinus.

Cambarus cubensis consobrinus Saussure, Rev. et. Mag. Zool., 1857, ser. 2, **9**, p. 101.

Type locality: — Ponds in the central part of Cuba. *Cotypes,* Geneva Mus. (2 ♂); Mus. Hist. Nat. Paris (1 ♂); Berlin Mus. (2 ♀); U. S. N. M., No. 20,684 (1 ♂ ex Geneva Mus.).

5b. Cambarus cubensis rivalis.

Cambarus cubensis rivalis Faxon, Bull. M. C. Z., October, 1912, **54**, p. 459.

Type locality: — San Diego de los Baños, Province of Pinar del Rio, Cuba. *Type,* M. C. Z., No. 7,406.

6. Cambarus atkinsoni.

Cambarus (*Procambarus*) *atkinsoni* Ortmann, Annals Carnegie Mus., May 5, 1913, **8**, p. 414.

Type locality: — Tributaries of Rio de los Indios, Los Indios, Isle of Pines. *Types,* Carnegie Mus. Pittsburgh, No. 74,924.

§ II. Third segment of third pair of legs of the male provided with hooks. First pair of abdominal legs of the male truncate, outer part closely applied to the inner and armed at the tip with from one to three horny, recurved teeth; inner part ending in a sharp spine generally directed outward. (Subgenus Cambarus of Ortmann, in part.)

7. Cambarus bouvieri.

Cambarus (*Cambarus*) *bouvieri* Ortmann, Ann. Sci. Nat., 1909, sér. 9, **7**, p. 159.

Type locality: — Uruapan, Michoacan, Mexico. *Cotypes,* Mus. Hist. Nat. Paris (2 ♂ f. I., 1 ♀); Carnegie Mus. Pittsburgh (1 ♂ f. I.).

8. Cambarus simulans.

Cambarus simulans Faxon, Proc. Amer. Acad., 1884, **20**, p. 112.

Cambarus gallinus Cockerell and Porter, Proc. Acad. Nat. Sci. Philad., 1900,

p. 434. *Type locality:* — Gallinas River at Las Vegas, N. Mex. *Types,* U. S. N. M., No. 23,916; *paratypes,* M. C. Z., No. 7,342; Acad. Nat. Sci. Philad.

Type locality: — Dallas, Texas. *Types,* M. C. Z., No. 3,646; *paratypes,* M. C. Z., No. 3,647; U. S. N. M., No. 4,150; St. Petersburg Mus.

9. Cambarus gracilis.

Cambarus gracilis Bundy, Bull. Illinois State Lab. Nat. Hist., Dec. 1876, **1**, p. 5.

Type locality: — Normal, McLean Co., Ill., and Racine, Racine Co., Wisconsin. *Cotypes,* Ill. State Lab. Nat. Hist., Urbana, Ill.; M. C. Z., No. 3,794 (Normal, Ill.), No. 3,454 (Racine, Wis.).

10. Cambarus hagenianus.

Cambarus hagenianus Faxon, Proc. Amer. Acad., 1884, **20**, p. 141.

Type locality: — Charleston, S. C. *Type,* M. C. Z., No. 232 (1 ♂ f. I.).

11. Cambarus advena.

Cambarus advena LeConte, Proc. Acad. Nat. Sci. Philad., 1855, **7**, p. 402.

Type locality: — Lower Georgia. *Cotypes,* M. C. Z., No. 3,379; Acad. Nat. Sci. Philad.

§ III. Third segment of third and fourth pairs of legs of the male furnished with a hook. First pair of abdominal appendages of male truncate, outer part closely applied to inner part and armed at the end with from one to three horny recurved teeth; inner part ending in a sharp spine which is often directed outward. (Subgen. Cambarus of Ortmann in part.)

12. Cambarus spiculifer.

Astacus spiculifer Le Conte, Proc. Acad. Nat. Sci. Philad., 1855, **7**, p. 401.

Type locality: — Athens, Clarke Co., Georgia. *Cotypes,* M. C. Z., No. 3,376 (1 ♂ f. I.); Acad. Nat. Sci. Philad. (1 ♂ f. II); *paratypes,* M. C. Z., No. 172 (11); U. S. N. M., No. 4,962 (1 ♂); Mus. Hist. Nat. Paris (2).

13. Cambarus versutus.

Cambarus versutus Hagen, Mem. M. C. Z., 1870, **2**, p. 51.

Type locality: — Spring Hill, Mobile Co., Ala. *Types,* M. C. Z., No. 190; *paratypes,* U. S. N. M., No. 4,963, (1 ♂); Mus. Hist. Nat. Paris (2); Australian Mus., Sydney.

14. Cambarus pubescens.

Cambarus pubescens Faxon, Proc. Amer. Acad., 1884, **20**, p. 109.

Type locality: — McBean Creek, Augusta, Georgia. *Types,* U. S. N. M., No. 3,181 (1 ♂ f. II., 1 ♀); *paratypes,* M. C. Z., No. 3,551 (2 ♀).

15. Cambarus angustatus.

Cambarus angustatus LeConte, Proc. Acad. Nat. Sci. Philad., 1855, **7**, p. 401.

Type locality: — Lower Georgia, in streams of clear water, between sand-hills. *Type,* Acad. Nat. Sci. Philad. (1 ♂ f. I.).

16. Cambarus lecontei.

Cambarus lecontei Hagen, Mem. M. C. Z., 1870, **2**, p. 47.

Type locality: — Mobile, Ala. *Types,* M. C. Z., No. 217; *paratypes,* U. S. N. M., No. 4,958; Mus. Hist. Nat. Paris (2); Mus. Würzburg (2); Mus. St. Petersburg (2); Australian Mus., Sydney.

17. Cambarus blandingii.

Astacus blandingii Harlan, Trans. Amer. Philos. Soc., 1830, **3**, p. 464.

Type locality: — Marshes and rivulets, Southern United States [Camden, Kershaw Co., S. C.?]. *Type,* Acad. Nat. Sci. Philad. (1 ♂).

17a. Cambarus blandingii acutus.

Cambarus acutus Girard, Proc. Acad. Nat. Sci. Philad., 1852, **6**, p. 91.

Cambarus acutissimus Girard, Proc. Acad. Nat. Sci. Philad., 1852, **6**, p. 91. *Type locality:* — Affluent of Mobile River, Kemper Co., Miss. *Type* probably destroyed in the Chicago fire in 1871; *paratypes* (?), Acad. Nat. Sci. Philad. (2).

Type locality: — Affluent of Mobile River, Kemper Co., Miss. *Type* probably destroyed in the Chicago fire in 1871.

18. Cambarus hayi.

Cambarus hayi Faxon, Proc. Amer. Acad., 1884, **20**, p. 108.

Type locality: — Macon, Noxubee Co., Miss. *Type,* M. C. Z., No. 3,533; *paratypes,* U. S. N. M., No. 19,752, 21,850.

19. Cambarus fallax.

Cambarus fallax Hagen, Mem. M. C. Z., 1870, **2**, p. 45.

Type locality: — Florida. *Cotypes,* Boston Soc. Nat. Hist. (1 ♂ f. II., 1 ♀); M. C. Z., No. 3526 (1 ♂ f. I., 1 ♂ f. II.).

20. Cambarus acherontis.

Cambarus acherontis Lönnberg, Bihang K. Svenska Vet.-Akad. Handl., 1894, **20**, af. 4, no. 1, p. 6.

Type locality: — Subterranean rivulet about 42 feet from surface, Lake Brantley, Orange Co., Fla.

21. Cambarus clarkii.

Cambarus clarkii Girard, Proc. Acad. Nat. Sci. Philad., 1852, **6**, p. 91.

Type locality: — Between San Antonio and El Paso del Norte, Texas. *Types* probably destroyed in the Chicago fire in 1871.

21a. Cambarus clarkii paeninsulanus.

Cambarus clarkii paeninsulanus Faxon, supra, p. 369.

Type locality: — Three miles below Horse Landing, St. John's River, Florida. *Type*, M. C. Z., No. 3,530 (1 ♂, f. II.); *paratypes*, U. S. N. M., No. 28,587, 28,589; M. C. Z., No. 7,370 (Beecher Point, St. John's River, Fla.).

22. Cambarus troglodytes.

Astacus troglodytes LeConte, Proc. Acad. Nat. Sci. Philad., 1855, **7**, p. 400.

Astacus fossarum LeConte, Proc. Acad. Nat. Sci. Philad., 1855, **7**, pl. 401. *Type locality:* — Ditches, Lower Georgia. *Cotypes*, M. C. Z., No. 3377; Acad. Nat. Sci. Philad.

Type locality: — Rice-fields, Georgia. *Cotypes*, M. C. Z., No. 3,375 (♂, f. I.); Acad. Nat. Sci. Phila. (♂ f. I.).

23. Cambarus evermanni.

Cambarus evermanni Faxon, Proc. U. S. Nat. Mus., May 22, 1890, **12**, p. 620.

Type locality: — Escambia River, at Flomaton, Escambia Co., Ala. *Type*, M. C. Z., No. 3,834 (1 ♂ f. I.).

24. Cambarus viae-viridis.

Cambarus viae-viridis Faxon, supra, p. 370.

Type locality: — St. Francis River, Greenway, Clay Co., Arkansas. *Type*, M. C. Z., No. 7,336.

25. Cambarus barbatus.

Astacus penicillatus LeConte (nec Olivier, 1791), Proc. Acad. Nat. Sci. Philad., 1855, **7**, p. 401. *Type locality:* — Lower Georgia.

Cambarus barbatus Faxon, Proc. U. S. Nat. Mus., May 22, 1890, **12**, p. 621. *Type locality:* — Georgia. *Type*, M. C. Z., No. 279 (1 ♂ f. I.); *paratypes*, M. C. Z., No. 3,845, Escambia River, Flomaton, Alabama.

26. Cambarus wiegmanni.

Astacus (*Cambarus*) *wiegmanni* Erichson, Archiv Naturgesch., 1846, **12**, 1, p. 99.

Type locality: — Mexico. *Type* apparently lost from the Berlin Mus.

27. Cambarus hinei.

Cambarus (*Cambarus*) *hinei* Ortmann, Ohio Naturalist, Dec. 1905, **6**, p. 401.

Type locality: — Near Cameron, Cameron Co., La.

28. Cambarus alleni.

Cambarus alleni Faxon, Proc. Amer. Acad., 1884, **20**, p. 110.

Type locality: — St. John's River, Hawkinsville, Orange Co., Fla. *Type*, M. C. Z., No. 3,531 (1 ♂ f. I.).

29. Cambarus pellucidus.

Astacus pellucidus Tellkampf, Arch. Anat. Physiol. wiss. Med., 1844, p. 383.

Orconectes inermis Cope, Amer. Nat., July, 1872, **6**, p. 419; 3d and 4th Ann. Rept. Geol. Surv. Indiana, 1872, p. 173. *Type locality:* — Wyandotte Cave, Indiana.

Type locality: — Mammoth Cave, Kentucky. *Type*, Berlin Mus.

29a. Cambarus pellucidus testii.

Cambarus pellucidus, var. *testii* Hay, Proc. Indiana Acad. Sci., 1891, p. 148; Proc. U. S. Nat. Mus., Sept. 28, 1893, **16**, p. 285.

Type locality: — Mayfield's Cave, Monroe Co., Ind. *Types*, U. S. N. M., No. 17,702; *paratypes*, U. S. N. M., No. 19,765, 19,766, 22,431; M. C. Z., No. 7,431.

§ IV. Third segment of fourth pair of legs of male hooked. Inner and outer parts of the first pair of abdominal appendages of male closely appressed, outer part terminating in a recurved horny (in form I.) tooth; the inner part giving off a long horny (in form I.) spine at an acute angle with the axis of the limb. (Subgen. Paracambarus of Ortmann.)

30. Cambarus paradoxus.

Cambarus (*Paracambarus*) *paradoxus* Ortmann, Proc. Washington Acad. Sci., May 3, 1906, **8**, p. 3.

Type locality: — Sierra de Zacapoaxtla, State of Puebla, Mexico ("ruisseaux torrentueux des montagnes, a le cañada de Tetela de Ocampo"). *Types*,

Mus. Hist. Nat. Paris (1 ♂ f. I., 1 ♂ f. II., 1 ♀); *paratypes*, Carnegie Mus. Pittsburgh; M. C. Z., No. 6,955 (1 ♂ f. I., 1 ♂ f. II., 1 ♀).

§ V. Third segment of second and third pairs of legs of male hooked. First pair of abdominal appendages of male not truncate, inner and outer parts separate and divergent for some distance from the tip; outer branch cleft into two slender teeth at the end; inner branch either acute or spatulate at the tip. (Subg. CAMBARELLUS of Ortmann.)

31. CAMBARUS SHUFELDTII.

Cambarus shufeldtii Faxon, Proc. Amer. Acad., 1884, **20**, p. 134.

Type locality: — Near New Orleans, La. *Cotypes*, U. S. N. M., No. 4,860; M. C. Z., No. 3,684.

32. CAMBARUS MONTEZUMAE.

Cambarus montezumae Saussure, Rev. et Mag. Zool., 1857, sér. 2, **9**, p. 102.

Type locality: — Swamps of the Valley of Mexico; specifically, ponds in the park of Chapultepec, Mexico. *Cotypes*, Geneva Mus.; Berlin Mus.; U. S. N. M., No. 20,683 (ex Geneva Mus.).

32a. CAMBARUS MONTEZUMAE DUGESII.

Cambarus montezumae dugesii Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 660.

Type locality: — State of Guanajuato, Mexico. *Types*, U. S. N. M., No. 16,087; *paratypes*, M. C. Z., No. 4,339.

32b. CAMBARUS MONTEZUMAE AREOLATUS.

Cambarus montezumae, var. *areolata* Faxon, Mem. M. C. Z., 1885, **10**, p. 123.

Type locality: — Near Parras, Cohahuila, Mexico. *Type*, M. C. Z., No. 3,650.

32c. CAMBARUS MONTEZUMAE CHAPALANUS.

Cambarus chapalanus Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 661.

Type locality: — Lake Chapala, State of Jalisco, Mexico. *Type*, U. S. N. M., No. 17,698 (1 ♂); *paratypes*, U. S. N. M., No. 16,294 (2 ♂); M. C. Z., No. 4,777 (1 ♂).

32d. CAMBARUS MONTEZUMAE OCCIDENTALIS.

Cambarus montezumae occidentalis Faxon, Proc. U. S. N. M., Feb. 17, 1898, **20**, p. 661.

Type locality: — Mazatlan, State of Cinaloa, Mexico. *Types*, M. C. Z., No. 3,652.

§ VI. Third segment of third pair of legs of male hooked. First pair of abdominal appendages of male (usually elongate) split into two rami, straight or somewhat recurved, and acute at the tips. (Subg. FAXONIUS of Ortmann.)

33. CAMBARUS HARRISONII.

Cambarus harrisonii Faxon, Proc. Amer. Acad., 1884, **20**, p. 130.

Type locality: — Irondale, Washington Co., Mo. *Types*, M. C. Z., No. 3,586; *paratypes*, U. S. N. M., No. 25,826.

34. CAMBARUS SLOANII.

Cambarus sloanii Bundy, Bull. Illinois State Lab. Nat. Hist., Dec., 1876, **1**, p. 24.

Type locality: — New Albany, Floyd Co., Ind. *Types*, M. C. Z., No. 3,806 (1 ♂ f. I., 1 ♀).

35. CAMBARUS INDIANENSIS.

Cambarus indianensis Hay, 20th Ann. Rept. Depart. Geol. & Nat. Resources Indiana, 1896, p. 494.

Type locality: — Patoka River at Patoka, Gibson Co., Ind. *Types*, U. S. N. M., No. 14,624, 2 ♂ f. I., 2 ♀; *paratypes*, M. C. Z., No. 3,859, 2 ♂ f. I., 2 ♀.

36. CAMBARUS AFFINIS.

?Cambarus limosus Rafinesque, Amer. Monthly Mag. & Crit. Rev., Nov. 1817, **2**, p. 42. *Type locality:* — In the muddy banks of the Delaware River, near Philadelphia, Pa. (Indeterminable from the description; types not extant.)

Cambarus affinis Say, Journ. Acad. Nat. Sci. Philad., 1817, **1**, p. 168.

Cambarus pealei Girard, Proc. Acad. Nat. Sci. Philad., 1852, **6**, p. 87. *Type locality:* — Potomac River at Washington, D. C. *Type*, U. S. N. M., No. 2,081 (2 ♂, 2 ♀).

Type locality: — Delaware River.

37. CAMBARUS PROPINQUUS.

Cambarus propinquus Girard, Proc. Acad. Nat. Sci. Philad., 1852, **6**, p. 88.

Type locality: — Garrison Creek, Sacket Harbor, Jefferson Co., N. Y., Four-mile Creek, Oswego, Oswego Co., N. Y. *Types* probably destroyed in the Chicago fire in 1871; *paratype* (?), Acad. Nat. Sci. Philad. (1 ♂).

37a. CAMBARUS PROPINQUUS SANBORNII.

Cambarus sanbornii Faxon, Proc. Amer. Acad., 1884, **20**, p. 128.

Type locality: — Oberlin, Lorain Co., Ohio. *Types*, M. C. Z., No. 3,692; *paratypes*, M. C. Z., No. 3,587 (Smoky Creek, Carter Co., Ky.).

38. Cambarus obscurus.

Cambarus obscurus Hagen, Mem. M. C. Z., 1870, **2**, p. 69.

Type locality: — Genesee River, Rochester, Monroe Co., N. Y. *Cotypes*, M. C. Z., No. 181, 3,353, 3,354; U. S. N. M., No. 4,971; Mus. Hist. Nat. Paris; Würzburg Mus.; Australian Mus., Sydney.

39. Cambarus erichsonianus.

Cambarus erichsonianus Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 659.

Type locality: — Rip Roaring Fork, five miles northwest of Greeneville, Greene Co., Tenn. *Cotypes*, U. S. N. M., No. 20,787; M. C. Z., No. 4,347.

40. Cambarus rusticus.

Cambarus rusticus Girard, Proc. Acad. Nat. Sci. Philad., 1852, **6**, p. 88.

Cambarus placidus Hagen, Mem. M. C. Z., 1870, **2**, p. 65. *Type locality:* — Lebanon, Wilson Co., Tenn.; Quincy, Adams Co., Ill.; Texas. *Cotypes*, M. C. Z., No. 289, 296, 170; U. S. N. M., No. 4,966; Mus. Hist. Nat. Paris; Würzburg Mus.; Australian Mus., Sydney.

Cambarus juvenilis Hagen, Mem. M. C. Z., 1870, **2**, p. 66. *Type locality:* — Little Hickman, Jessamine Co., Ky. *Cotypes*, M. C. Z., No. 213, 3,347; U. S. N. M., No. 4,967; Mus. Hist. Nat. Paris; Würzburg Mus.; Australian Mus.

Cambarus wisconsinensis Bundy, Bull. Ill. State Lab. Nat. Hist., Dec., 1876, **1**, p. 4. *Type locality:* — Racine, Racine Co., Wisconsin. *Type*, M. C. Z., No. 3,448 (1 ♂ f. II).

Type locality: — Ohio River, at Cincinnati, Ohio. *Types* probably destroyed in the Chicago fire in 1871; *paratype* (?), Acad. Nat. Sci. Philad.

41. Cambarus forceps.

Cambarus forceps Faxon, Proc. Amer. Acad., 1884, **20**, p. 133.

Type locality: — Cypress Creek, Lauderdale Co., Ala. *Cotypes*, U. S. N. M., No. 4,880; M. C. Z., No. 3,582.

42. Cambarus neglectus.

Cambarus neglectus Faxon, Bull. Washburn College Lab. Nat. Hist., Oct. 31, 1885, **1**, p. 142.

Type locality: — Mill Creek, Wabaunsee Co., Kansas. *Cotypes*, M. C. Z., No. 3,757; Mus. Washburn College, Topeka, Kans.

43. Cambarus spinosus.

Cambarus spinosus Bundy, Proc. Acad. Nat. Sci. Philad., 1877, p. 173.

Type locality: — Etowah, Oostanaula, and Coosa Rivers, near Rome, Floyd Co., Georgia. *Cotypes*, M. C. Z., No. 3,540, 3,541 (4 ♂ f. II., 3 ♀); U. S. N. M., No. 19,779 (3 ♂ f. II., 2 ♀).

43a. Cambarus spinosus gulielmi.

Cambarus spinosus gulielmi Faxon, supra p. 375.

Type locality: — Near Rossville, Walker Co., Georgia. *Types*, U. S. N. M., No. 26,379; *paratypes*, M. C. Z., No. 7,448 (1 ♂ f. II., 1 ♀).

44. Cambarus putnami.

Cambarus putnami Faxon, Proc. Amer. Acad., 1884, **20**, p. 131.

Type locality: — Bear Creek, a tributary of Green River, Grayson Springs, Grayson Co., Ky. *Types*, M. C. Z., No. 3,568; *paratypes*, M. C. Z., No. 3,569 (Green River, near Mammoth Cave, Ky.), No. 3,570 (Rocky Creek, near Grayson Springs, Ky., 1 ♂); U. S. N. M., No. 10,130 (Grayson Springs, Ky.); St. Petersburg Mus. (Green River, Ky., 1 ♂, 2 ♀).

45. Cambarus hylas.

Cambarus hylas Faxon, Proc. U. S. Nat. Mus., May 22, 1890, **12**, p. 632.

Type locality: — West Fork of Black River, Reynolds Co., Mo. *Types*, M. C. Z., No. 3,858; *paratypes*, U. S. N. M., No. 25,827 (1 ♂, 1 ♀).

46. Cambarus medius.

Cambarus medius Faxon, Proc. Amer. Acad., 1884, **20**, p. 121.

Type locality: — Irondale, Washington Co., Mo. *Types*, M. C. Z., No. 3,585 (1 ♂ f. I., 1 ♀).

47. Cambarus compressus.

Cambarus compressus Faxon, Proc. Amer. Acad., 1884, **20**, p. 127.

Type locality: — Second Creek, Waterloo, Lauderdale Co., Ala. *Cotypes*, U. S. N. M., No. 4,878; M. C. Z., No. 3,583.

48. Cambarus meeki.

Cambarus meeki Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 657.

Type locality: — Walnut Fork of Big Piney Creek, Swain, Newton Co., Ark. *Types*, M. C. Z., No. 4,363; *paratypes*, U. S. N. M., No. 19,680; Mus. Zool. Torino.

49. Cambarus longidigitus.

Cambarus longidigitus Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 653.

Cambarus whitmani Steele, Univ. Cincinnati Bull., 1902, no. 10, p. 24. *Type locality:* — James River, Mo.

Type locality: — Oxford Bend, White River, [Izard Co.?], Ark. *Types*, M. C. Z., No. 4,364; *paratypes*, U. S. N. M., No. 19,683.

50. Cambarus virilis.

Cambarus virilis Hagen, Mem. M. C. Z., 1870, **2**, p. 63.

Cambarus debilis Bundy, Bull. Illinois State Lab. Nat. Hist., Dec., 1876, **1**, p. 24. *Type locality:* — Baraboo River, Ironton, Sauk Co., Wis. *Cotype*, M. C. Z., No. 3,449 (1 ♂ f. II.).

Cambarus couesi Streets, Bull. U. S. Geol. Surv. Terr., 1877, **3**, p. 803. *Type locality:* — Red River of the North, near Pembina, Pembina Co., N. Dakota. *Cotypes*, U. S. N. M., No. 3,154; M. C. Z., No. 3,545.

Cambarus viridis Moenkhaus, Proc. Indiana Acad. Sci. for 1902, 1903, p. 111 (*per errorem vice "virilis"*).

Type locality: — Lake Superior. *Types*, M. C. Z., No. 1,151; *paratypes*, M. C. Z., No. 194, 203 (Lake Superior), No. 196 (Quincy, Ill.), No. 3,342 (Lake Winnipeg), No. 3,343 (Red River of the North), No. 3,344 (Saskatchewan River); Mus. Hist. Nat. Paris (Lake Superior); Würzburg Mus. (Lake Superior); Australian Mus., Sydney.

51. Cambarus pilosus.

Cambarus pilosus Hay, Proc. U. S. Nat. Mus., Oct. 11, 1899, **22**, p. 121.

Type locality: — Beloit, Mitchell Co., Kansas. *Cotypes*, U. S. N. M., No. 19,761 (6 ♂ f. II.); M. C. Z., No. 7,389 (1 ♂ f. II.).

52. Cambarus alabamensis.

Cambarus alabamensis Faxon, Proc. Amer. Acad., 1884, **20**, p. 125.

Type locality: — Second Creek, Waterloo, Lauderdale Co., Ala. *Cotypes*, U. S. N. M., No. 4,876; M. C. Z., No. 3,565.

53. Cambarus nais.

Cambarus nais Faxon, Bull. Washburn College Lab. Nat. Hist., 1885, **1**, p. 140.

Type locality: — Labette Co., Kansas. *Cotypes*, Mus. Washburn College, Topeka, Kan.; M. C. Z., No. 3,755.

54. Cambarus immunis.

Cambarus immunis Hagen, Mem. M. C. Z., 1870, **2**, p. 71.

Cambarus signifer Herrick, 10th Ann. Rept. Geol. Surv. Minn., 1882, p. 253.

Type locality: — Grass Lake, Richfield, Hennepin Co., Minn. *Cotype,* M. C. Z., No. 3,515, (2 ♂ f. I., 1 ♀).

Type locality: — Lawn Ridge, Ill. *Types,* M. C. Z., No. 188; *paratypes,* M. C. Z., No. 3,355 (Belleville, Saint Clair Co., Ill.); Mus. Hist. Nat. Paris (Lawn Ridge, Ill., 1 ♂).

54a. Cambarus immunis spinirostris.

Cambarus immunis spinirostris Faxon, Proc. Amer. Acad., 1884, **20**, p. 146.

Type locality: — Creek running into the east side of Redfoot Lake, near Idlewild Hotel, Obion Co., Tennessee. *Cotypes,* U. S. N. M., No. 4,655; M. C. Z., No. 3,562.

55. Cambarus validus.

Cambarus validus Faxon, supra, p. 382.

Type locality: — Huntsville, Madison Co., Ala. *Type,* M. C. Z., No. 301 (1 ♂ f. I.).

56. Cambarus palmeri.

Cambarus palmeri Faxon, Proc. Acad., 1884, **20**, p. 124.

Type locality: — Creek running into the east side of Redfoot Lake, near Idlewild Hotel, Obion Co., Tenn. *Cotypes,* U. S. N. M., No. 4,872; M. C. Z., No. 3,564.

56a. Cambarus palmeri longimanus.

Cambarus palmeri longimanus Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 655.

Type locality: — Red River, Arthur City, Lamar Co., Texas. *Types,* M. C. Z., No. 7,390; *paratypes,* M. C. Z., No. 4,361, 4,362, (Goodland, and Kiamichi, Indian Terr. [now Oklahoma]); U. S. N. M., No. 19,684 (Arthur, Tex., Indian Terr.); Mus. Zool. Torino.

57. Cambarus difficilis.

Cambarus difficilis Faxon, Proc. U. S. Nat. Mus., Feb. 17, 1898, **20**, p. 656.

Type locality: — Creek tributary to a southern branch of the Canadian River, McAlester, Pittsburg Co., Oklahoma. *Types,* M. C. Z., No. 4,359; *paratypes,* U. S. N. M., No. 19,687; Mus. Zool. Torino.

58. Cambarus mississippiensis.

Cambarus mississippiensis Faxon, Proc. Amer. Acad., 1884, **20**, p. 123.

Type locality: — Macon, Noxubee Co., Miss. *Types*, Coll. O. P. Hay; *paratype*, M. C. Z., No. 3,563 (1 ♀).

59. Cambarus lancifer.

Cambarus lancifer Hagen, Mem. M. C. Z., 1870, **2**, p. 59.

Cambarus faxonii Meek, Amer. Nat., Dec. 1894, **28**, p. 1042. *Type locality:* St. Francis River at Greenway and Big Bay, Arkansas. *Cotypes*, U. S. N. M., No. 19,331; M. C. Z., No. 4,220; Mus. Zool. Torino.

Type locality: — Root Pond, Miss. *Type*, M. C. Z., No. 306 (1 ♂ f. I.).

§ VII. Third segment of third pair of legs of male hooked. First pair of abdominal appendages of male short and thick, terminating in two large recurved tooth-like processes, the larger formed by the outer part of the appendage, the smaller by the inner. (Subgen. Bartonius of Ortmann.)

60. Cambarus hamulatus.

Orconectes hamulatus Cope and Packard, Amer. Nat., Nov. 1881, **15**, p. 881.

Type locality: — Nickajack Cave, Tennessee. *Cotypes*, M. C. Z., No. 3,678 (1 ♂ f. II., 1 ♀).

61. Cambarus setosus.

Cambarus setosus Faxon, Bull. M. C. Z., Dec. 1889, **17**, p. 237.

Type locality: — Wilson's Cave, Jasper Co., Missouri. *Types*, M. C. Z., No. 4,200; *paratypes*, M. C. Z., No. 4,201, 4,202; U. S. N. M., No. 25,828.

62. Cambarus ayersii.

Cambarus ayersii Steele, Univ. Cincinnati Bull., 1902, No. 10, p. 18.

Type locality: — Fisher's Cave, near Springfield, Greene Co., Missouri.

63. Cambarus extraneus.

Cambarus extraneus Hagen, Mem. M. C. Z., 1870, **2**, p. 73.

Type locality: — Tennessee River, Tenn., near the boundary of Georgia. *Types*, M. C. Z., No. 175; *paratype*, U. S. N. M., No. 4,957.

63a. Cambarus extraneus girardianus.

Cambarus girardianus Faxon, Proc. Amer. Acad., 1884, **20**, p. 117.

Type locality: — Cypress Creek, Lauderdale Co., Ala. *Cotypes*, U. S. N. M., No. 4,882; M. C. Z., No. 3,560.

64. Cambarus jordani.

Cambarus jordani Faxon, Proc. Amer. Acad., 1884, **20**, p. 119.

Type locality: — Etowah River, near Rome, Floyd Co., Georgia. *Type*, M. C. Z., No. 3,561 (1 ♂ f. II.).

65. Cambarus cornutus.

Cambarus cornutus Faxon, Proc. Amer. Acad., 1884, **20**, p. 120.

Type locality: — Green River near Mammoth Cave, Kentucky. *Type*, M. C. Z., No. 3,566 (1 ♂ f. I.).

66. Cambarus bartonii.

Astacus bartonii Fabricius, Suppl. Entomol. Syst., 1798, p. 407.

Astacus ciliaris Rafinesque, Amer. Monthly Mag. and Crit. Rev., Nov. 1817, **2**, p. 42. *Type locality:* — Brooks near Fishkill, Dutchess Co., and Newburgh, Orange Co., New York.

Astacus pusillus Rafinesque, Amer. Monthly Mag. and Crit. Rev., Nov. 1817, **2**, p. 42. *Type locality:* — Brooks near Saratoga Springs, Saratoga Co., N. Y.; Lake George, N. Y.; Lake Champlain; Utica, Oneida Co., N. Y.; Oswego, Oswego Co., N. Y.

Type locality:— North America [probably neighborhood of Philadelphia, Pa.]. *Type* (fragment only), Kiel Museum.

66a. Cambarus bartonii carinirostris.

Cambarus bartonii carinirostris Hay, supra, p. 384.

Type locality: — Gandy Creek, Osceola, Randolph Co., West Virginia. *Type*, U. S. N. M., No. 23,962; *paratypes*, M. C. Z., No. 7,399.

66b. Cambarus bartonii montanus.

Cambarus montanus Girard, Proc. Acad. Nat. Sci. Philad., 1852, **6**, p. 88.

Type locality: — Within the Alleghany ranges in Virginia, West Virginia, and Maryland; tributaries of James River, Rockbridge Co., Va.; Shenandoah River, Clarke Co., Va.; Cumberland, Allegany Co., Md.; Sulphur Spring, Greenbrier River, W. Va. *Types* probably destroyed in the Chicago fire in 1871; *paratype* (?), Acad. Nat. Sci. Philad. (1 ♂ juv., James River, Va.).

66c. Cambarus bartonii robustus.

Cambarus robustus Girard, Proc. Acad. Nat. Sci. Philad., 1852, **6**, p. 90.

Type locality: — Humber River, near Toronto, Canada. *Type* probably destroyed in the Chicago fire in 1871; *paratype* (?), Acad. Nat. Sci. Philad. (1 ♂).

66d. Cambarus bartonii longirostris.

Cambarus bartonii, var. *longirostris* Faxon, Mem. M. C. Z., Oct. 1885, **10**, p. 64.

Cambarus bartonii spinirostris Faxon, Proc. U. S. Nat. Mus., May 22, 1890, **12**, p. 623 (*lapsu calami pro "longirostris"*).

Type locality: — Near the boundary between western North Carolina and eastern Tennessee. *Type*, M. C. Z., No. 3,629 (1 ♂ f. II.).

66e. Cambarus bartonii longulus.

Cambarus longulus Girard, Proc. Acad. Nat. Sci., Philad., 1852, **6**, p. 90.

Type locality: — Unknown; "its range however, is within the Middle States of the Union." *Type* probably destroyed in the Chicago fire in 1871.

66f. Cambarus bartonii veteranus.

Cambarus bartonii veteranus Faxon, supra, p. 389.

Type locality: — Indian Creek, Baileysville, Wyoming Co., West Virginia. *Type*, U. S. N. M., No. 44,712; *paratypes*, U. S. N. M., No. 25,020; M. C. Z., No. 7,402.

66g. Cambarus bartonii asperimanus.

Cambarus bartonii asperimanus Faxon, supra, p. 391.

Type locality: — Flat Creek, near Montreat, Buncombe Co., N. C. *Types*, U. S. N. M., No. 47,375 (2 ♂ f. I.).

66h. Cambarus bartonii acuminatus.

Cambarus acuminatus Faxon, Proc. Amer. Acad., 1884, **20**, p. 113.

Type locality: — Saluda River at Farr's Mills, west of Greenville, Greenville Co., South Carolina. *Cotypes*, Butler Univ., Irvington, Ind. (1 ♂ f. II., 1 ♀); M. C. Z., No. 3,624 (1 ♀).

66i. Cambarus bartonii laevis.

Cambarus bartonii laevis Faxon, supra, p. 391.

Type locality: — Bloomington, Monroe Co., Indiana. *Types*, M. C. Z., No. 3,812.

66j. Cambarus bartonii tenebrosus.

Cambarus bartonii tenebrosus Hay, Proc. U. S. Nat. Mus., Sept. 12, 1902, **25**, p. 232.

Type locality: — Mammoth Cave, Kentucky. *Types*, U. S. N. M., No. 22,346.

66k. Cambarus bartonii cavatus.

Cambarus bartonii cavatus Hay, Proc. U. S. Nat. Mus., Sept. 23, 1902, **25**, p. 435.

Type locality: — Powell River at Tazewell, Claiborne Co., Tennessee. *Types*, U. S. N. M., No. 25,017.

67. Cambarus latimanus.

Astacus latimanus LeConte, Proc. Acad. Nat. Sci. Philad., 1855, **7**, p. 402.

Type locality: — Athens, Clarke Co., Georgia. *Cotypes*, M. C. Z., No. 3,378 (1 ♂ f. I); Acad. Nat. Sci. Philad. (1 ♀); *paratypes*, M. C. Z., No. 236.

67a. Cambarus latimanus striatus.

Cambarus latimanus striatus Hay, Proc. U. S. Nat. Mus., Sept. 23, 1902, **25**, p. 437.

Type locality: — Nashville, Tenn. *Type*, U. S. N. M., No. 25,019; *paratype*, M. C. Z., No. 7,348.

68. Cambarus graysoni.

Cambarus graysoni Faxon, supra, p. 393.

Type locality: — Bear Creek, Grayson Springs, Grayson Co., Kentucky. *Types*, M. C. Z., No. 3,593.

69. Cambarus ortmanni.

Cambarus ortmanni Williamson, 31st Ann. Rept. Dept. Geol. Indiana, 1907, p. 754.

Type locality: — Six-Mile Creek and Craven Ditch, tributary to Wabash River, above Bluffton, Wells Co., Indiana. *Types*, Carnegie Mus., Pittsburgh; *paratypes*, Coll. W. P. Hay; M. C. Z., No. 7,587 (1 ♀).

70. Cambarus carolinus.

Astacus (Cambarus) carolinus Erichson, Arch. Naturgesch., 1846, **12**, p. 96.

Type locality: — Farm called "Tiger Hall," near Greenville, Greenville Co., S. C. *Type*, Berlin Mus. (1 ♂).

70a. Cambarus carolinus dubius.

Cambarus dubius Faxon, Proc. Amer. Acad., 1884, **20**, p. 114.

Type locality: — Cranberry Summit [now Terra Alta], Preston Co., West Virginia. *Type*, M. C. Z., No. 3,631.

70b. Cambarus carolinus monongalensis.

Cambarus monongalensis Ortmann, Annals Carnegie Mus., 1905, **3**, p. 395.

Type locality: — Head of Gordon's Valley, Edgewood Park, Allegheny Co., Pa. *Types*, Carnegie Mus.; *paratypes*, M. C. Z., No. 6,953; U. S. N. M., No. 30,613.

71. Cambarus diogenes.

Cambarus diogenes Girard, Proc. Acad. Nat. Sci. Philad., 1852, 6, p. 88.

?Cambarus nebrascensis Girard, Proc. Acad. Nat. Sci. Philad., 1852, 6, p. 91. *Type locality:* — Fort Pierre, Nebraska [now in Stanley Co., South Dakota].

Cambarus obesus Hagen, Mem. M. C. Z., 1870, 2, p. 81. *Type locality:* — Lawn Ridge, Illinois. *Types*, M. C. Z., No. 195; *paratypes*, M. C. Z., No. 165 (Belleville, Saint Clair Co., Ill.), No. 336 (Evanston, Cook Co., Ill.), No. 229 (Arkansas), No. 3,363 (Petersburg, Dinwiddie Co., Va.); Mus. Hist. Nat. Paris (Lawn Ridge, Ill., Belleville, Ill.); St. Petersburg Mus. (Belleville, Ill.).

Type locality: — Near Washington, D. C. *Paratype* (?), Acad. Nat. Sci. Philad.

71a. Cambarus diogenes ludovicianus.

Cambarus diogenes, var. *ludoviciana* Faxon, Proc. Amer. Acad., 1884, 20, p. 144.

Type locality: — New Orleans, La. *Cotypes*, U. S. N. M., No. 5,625; M. C. Z., No. 3,617.

72. Cambarus argillicola.

Cambarus argillicola Faxon, Proc. Amer. Acad., 1884, 20, p. 115.

Type locality: — Detroit, Mich. *Types*, M. C. Z., No. 3,459.

73. Cambarus uhleri.

Cambarus uhleri Faxon, Proc. Amer. Acad., 1884, 20, p. 116.

Type locality: — Swamp on Eastern Road near Felsburg, Somerset Co., Maryland. *Type* M. C. Z., No. 3,634 (1 ♂ f. I.); *paratypes*, M. C. Z., No. 3,633, 3,635, 3,636 (Dorchester, Somerset, and Worcester Cos., Md.).

74. Cambarus clypeatus.[1]

Cambarus clypeatus Hay, Proc. U. S. Nat. Mus., Oct. 11, 1899, 22, p. 122.

Type locality: — Bay Saint Louis, Hancock Co., Miss. (found in a skiff). *Type*, U. S. N. M., No. 22,778 (♀).

[1] The position of this species is doubtful, as only the female is known.

DOUBTFUL SPECIES, NOT INCLUDED IN THE PRECEDING LIST.

1. CAMBARUS MANICULATUS.

Astacus maniculatus LeConte, Proc. Acad. Nat. Sci. Philad., 1855, **7**, p. 401.

Type locality: — In ditches, Lower Georgia.

2. CAMBARUS STYGIUS.

Cambarus stygius Bundy, Bull. Illinois State Lab. Nat. Hist., 1876, **1**, p. 3.

Type locality: — Lake Michigan at Racine, Racine Co., Wisconsin (washed up during a violent storm).

3. CAMBARUS TYPHLOBIUS.

Cambarus typhlobius Joseph, 57th Jahresber. Schlesischen Gesellsch. vaterl. Cult., 1879, 1880, p. 202.

Cambarus coecus Joseph, Berl. Entomol. Zeitschr., Dec. 1881, **25**, p. 237.

Cambarus stygius Joseph, Berl. Entomol. Zeitschr., April, 1882, **26**, p. 12 (nec Bundy, 1876).

Type locality: — Recca River, Grotto of St. Kanzian at Metaùn, near Divazza, Carniola (doubtless an error).

EXPLANATION OF PLATES.

NOTE.— Plates 1–3 are after colour-drawings of living specimens, by E. N. Fischer. Plates 4–8 are from India-ink drawings by E. N. Fischer. Plates 9–13 are from photographs by George Nelson.

PLATE 1.

PLATE 1.

Fig. 1.— *Cambarus hagenianus* Faxon. ♀. Muldon, Miss. M. C. Z., No. 7,425. × 1.
Fig. 2.— *Cambarus hagenianus* Faxon. ♂. Muldon, Miss. M. C. Z., No. 7,425. × 1.

PLATE 2.

PLATE 2.

Fig. 1.— *Cambarus immunis spinirostris* Faxon. Young ♀. Pontoosuc Lake, Lanesboro, Mass., Aug. 12, 1911. M. C. Z., No. 7,364. × 3.

Fig. 2.— *Cambarus immunis spinirostris* Faxon. ♂, form I. Pontoosuc Lake, Lanesboro, Mass., Aug. 12, 1911. M. C. Z., No. 7,363. × 1.

PLATE 3.

PLATE 3.

Cambarus bartonii robustus (Girard). Bog River, St. Lawrence Co., N. Y., July, 1912. M. C. Z., No. 7,440. × 1½.

PLATE 4.

PLATE 4.

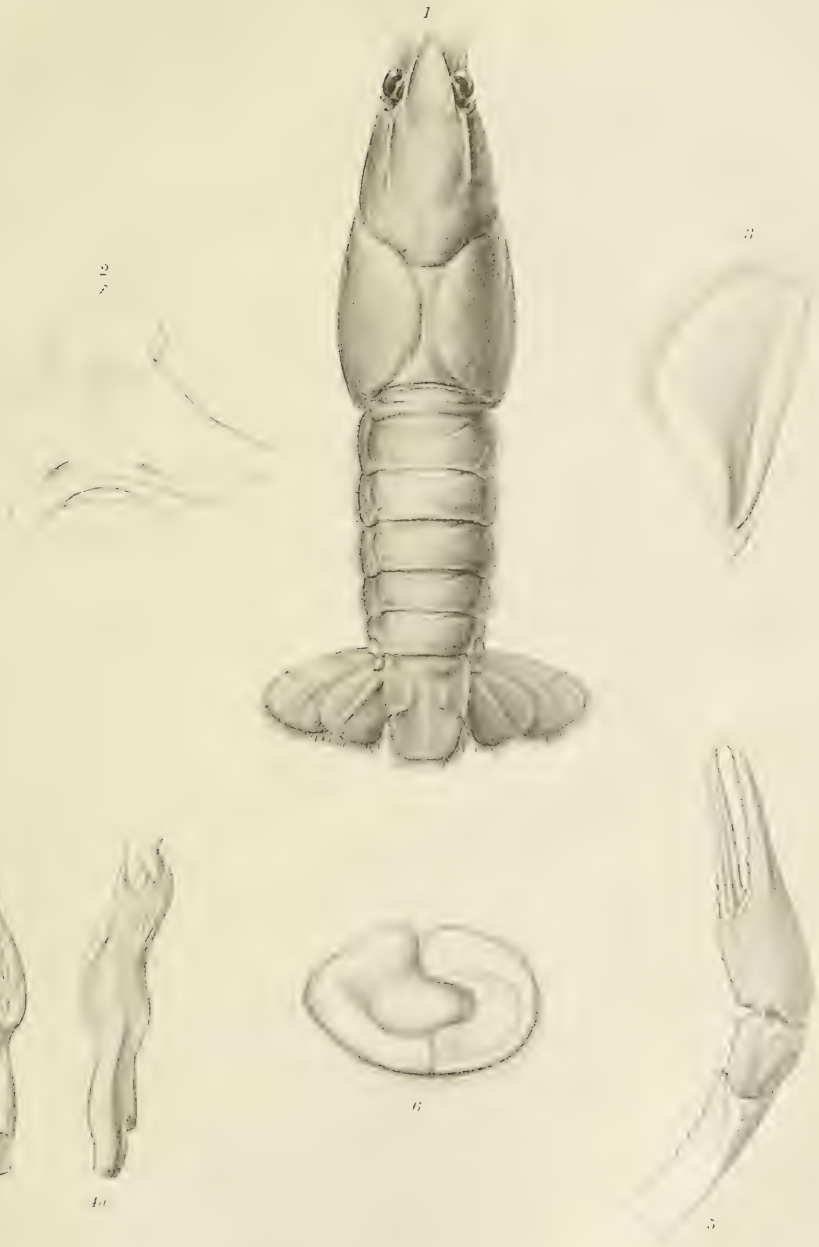
Fig. 1.— *Parastacus araucanius* Faxon. ♂. Corral, Chile, Dec. 18, 1908. Type. M. C. Z., No. 7,355.
Fig. 2.— Epistoma of the same.
Fig. 3.— Antennal scale from the right antenna, upper face.

PARASTACUS ARAUCANIUS FAXON.

PLATE 5.

PLATE 5.

Fig. 1.— *Cambarus viae-viridis* Faxon. ♂, form I. St. Francis R., Greenway, Ark., Aug., 1894. Type. M. C. Z., No. 7,336.
Fig. 2.— Epistoma of the same.
Fig. 3.— Antennal scale of the same.
Fig. 4.— Gonopod of the same, inner side.
Fig. 4*a*.— Gonopod of the same, outer side.
Fig. 5.— Right cheliped of the same.
Fig. 6.— Annulus ventralis of the female *Cambarus viae-viridis*.

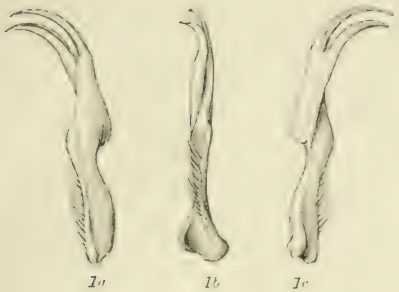


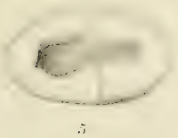
CAMBARUS VIAE-VIRIDIS FAXON

PLATE 6.

PLATE 6.

Fig. 1.— *Cambarus immunis spinirostris* Faxon. Pontoosuc Lake, Lanesboro, Mass., Aug. 12, 1911. M. C. Z., No. 7,363. Gonopod of the ♂, form I. 1*a*, outside, 1*b*, front, 1*c*, inside.
Fig. 2.— Gonopod of the ♂, form II. of the same, 2*a*, outside, 2*b*, front, 2*c*, inside.
Fig. 3.— Epistoma of the same.
Fig. 4.— Antennal scale of the same.
Fig. 5.— Annulus ventralis of the ♀ of the same.
Fig. 6.— Chela of the ♂, form I. of the same.





CAMBARUS IMMUNIS SPINIROSTRIS FAXON

PLATE 7.

PLATE 7.

Fig. 1.— *Cambarus hagenianus* Faxon. Muldon, Miss. Gonopod of ♂, form I. 1*a*, outer side, 1*b*, inner side, 1*c*, front.

Fig. 2.— *Cambarus pellucidus* (Tellkampf). Mammoth Cave, Ky. Gonopod of ♂, form I. 2*a*, outer side, 2*b*, inner side, 2*c*, front.

Fig. 3.— *Cambarus validus* Faxon. Huntsville, Ala. Type. M. C. Z., No. 301. Gonopod (♂ form I.). 3*a*, outer side, 3*b*, inner side, 3*c*, front.

Fig. 4.— *Cambarus validus* Faxon. Type. Antennal scale.

Fig. 5.— *Astacus nigrescens fortis* Faxon. ♂. Fall R., Fall City Mills, Cal. Type. U. S. N. M. Antennal scale.

Fig. 6.— *Astacus gambeli connectens* Faxon. ♂. Snake R., Upper Salmon Falls, Idaho. Type. U. S. N. M., No. 23,096. Antennal scale.

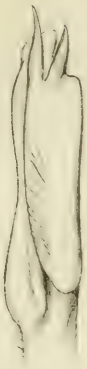
Fig. 7.— *Cambarus hagenianus* Faxon. ♀. Muldon, Miss. Annulus ventralis.

Fig. 8.— *Cambarus validus* Faxon. ♂. Type. Epistoma.

Fig. 9.— *Astacus nigrescens fortis* Faxon. ♂. Type. Epistoma.

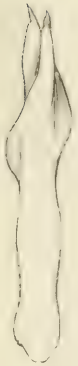
Fig. 10.— *Astacus gambelii connectens* Faxon. ♂. Type. Epistoma.

1a

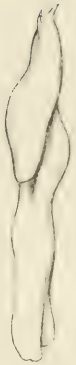


1b

1c



2a



2b

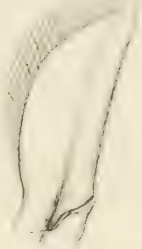
2c

3a

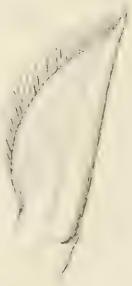
3b

3c

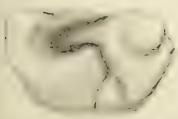
4



5

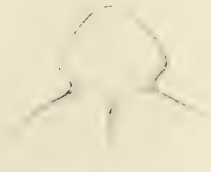


6



7

8



9

10

PLATE 8.

PLATE 8.

Fig. 1.— *Astacus astacus* (Linné). ♂. Leipzig, Germany. M. C. Z., No. 3403.
Fig. 1*a*.— Gonopod of the same.
Fig. 1*b*.— Chela of the same.
Fig. 1*c*.— Antennal scale of the same.
Fig. 1*d*.— Anterior process of the epistoma of the same.
Fig. 1*e*.— Profile of anterior end of rostrum of the same.
Fig. 1*f*.— Pleura of the second and third abdominal segments of the same.
Fig. 2.— *Astacus pallipes italicus* Faxon. ♂. Sarno R., Pompeii, Italy, June 10, 1900. Type. U. S. N. M., No. 28,638.
Fig. 2*a*.— Gonopod of the same.
Fig. 2*b*.— Chela of the same.
Fig. 2*c*.— Antennal scale of the same.
Fig. 2*d*.— Anterior process of the epistoma of the same.
Fig. 2*e*.— Profile of anterior end of rostrum of the same.
Fig. 2*f*.— Pleura of the second and third abdominal segments of the same.
Fig. 3.— *Astacus pallipes* Lereboullet. ♂. Saone R., Lyons, France. M. C. Z., No. 3,372.
Fig. 3*a*.— Gonopod of the same.
Fig. 3*b*.— Chela of the same.
Fig. 3*c*.— Antennal scale of the same.
Fig. 3*d*.— Anterior process of the epistoma of the same.
Fig. 3*e*.— Profile of anterior end of rostrum of the same.
Fig. 3*f*.— Pleura of the second and third abdominal segments of the same.

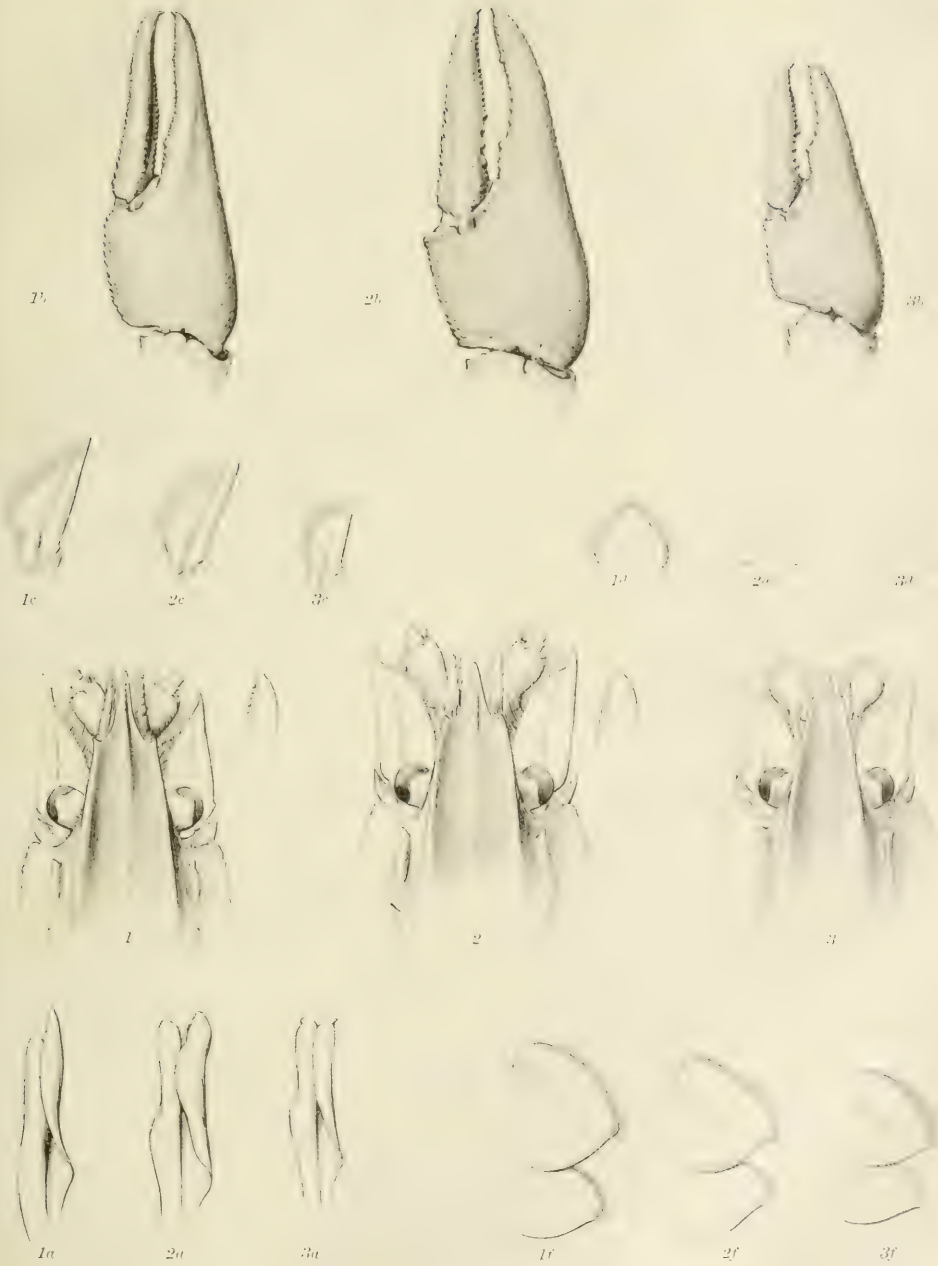


FIG. 1. ASTACUS ASTACUS (LINNÉ) FIG. 2. ASTACUS PALLIPES ITALICUS FAXON FIG. 3. ASTACUS PALLIPES LEREBOULLET

PLATE 9.

PLATE 9.

Fig. 1.— *Parastacus spinifrons* (Philippi)? Mus. d'Hist. Nat., Paris. × 1.
Fig. 2.— *Astacus nigrescens fortis* Faxon. ♂. Type. Fall R., Fall City Mills, Cal., Aug. 29, 1898. U. S. N. M. Slightly enlarged.

FIG. 1. PARASTACUS SPINIFRONS (PHILIPPI).

FIG. 2. ASTACUS NIGRESCENS FORTIS FAXON.

PLATE 10.

PLATE 10.

Fig. 1.— *Astacus gambelii connectens* Faxon. ♂. Type. Snake R., Upper Salmon Falls, Idaho, Oct. 3, 1894. U. S. N. M., No. 23,096. Enlarged.

Fig. 2.— *Astacus gambelii* with most of the characters of *A. g. connectens*. ♂. Mouth of St. Joe R., Coeur d'Alene Lake, Idaho. U. S. N. M. × 1.

FIG. 1. ASTACUS GAMBELII CONNECTENS FAXON

FIG. 2. ASTACUS GAMBELII CONNECTENS FAXON

PLATE 11.

PLATE 11.

Fig. 1.— *Astacus klamathensis* Stimpson. ♂. Portland, Or. U. S. N. M.; slightly enlarged. Showing the chelipeds of normal shape.

Fig. 2.— *Astacus klamathensis* Stimpson. ♂. Portland, Or. U. S. N. M., slightly reduced. Showing the abnormal, atavistic form of the regenerated claw of the left side.

FIG. 1. ASTACUS KLAMATHENSIS STIMPSON.

FIG. 2. ASTACUS KLAMATHENSIS STIMPSON.

PLATE 12.

PLATE 12.

Fig.— *Astacus klamathensis* Stimpson. ♂. Portland, Or. U. S. N. M. × 1. Both of the chelipeds are second growths, the left the older.

Fig. 2.— *Astacus klamathensis* Stimpson. ♂. Portland, Or. U. S. N. M. Slightly reduced. Showing both claws regenerated, of full size, and nearly symmetrical; yet very different in shape from the normal claw as seen in Plate 11, Fig. 1.

FIG. 1. ASTACUS KLAMATHENSIS STIMPSON

FIG. 2. ASTACUS KLAMATHENSIS STIMPSON

PLATE 13.

PLATE 13.

Fig. 1.— *Cambarus validus* Faxon. ♂, form I. Type. Huntsville, Ala. M. C. Z., No. 301. × 1½.
Fig. 2.— *Cambarus bartonii veteranus* Faxon. ♂, form I. Type. Indian Creek, Baileysville, W. Va. Aug. 16, 1900. U. S. N. M., No. 25,020. Reduced.

FIG. 1. CAMBARUS VALIDUS FAXON

FIG. 2. CAMBARUS BARTONII VETERANUS FAXON

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XL. No. 9.

STUDIES FROM THE NEWPORT MARINE LABORATORY.

Communicated by Alexander Agassiz.

XVI.

THE DEVELOPMENT OF OSSEOUS FISHES.

II.

THE PRE-EMBRYONIC STAGES OF DEVELOPMENT.

PART SECOND.—THE HISTORY OF THE EGG: CLEAVAGE, FORMATION OF THE PERIBLAST, AND DEVELOPMENT OF THE GERM RING.

BY

ALEXANDER AGASSIZ and C. O. WHITMAN.

WITH ELEVEN PLATES.

CAMBRIDGE, U.S.A.:
Printed for the Museum.
April, 1915.

PREFATORY NOTE.

The study of young fishes was one of the early zoölogical interests of Mr. Agassiz, and he had published a number of papers [1] previous to 1883 when the late Prof. C. O. Whitman joined the staff of the Museum of Comparative Zoölogy. During a part of the years 1883–1886, Professor Whitman worked upon the development of some pelagic fishes both at the Newport Laboratory and at the Museum, and some of the results of his studies were published in collaboration with Mr. Agassiz in the Proceedings of the American Academy and in the Memoirs of the Museum.[2]

Though the eleven plates for another part of the Memoirs to be "devoted to cleavage, formation of periblast and the development of the germ ring" were printed so long ago as October, 1885, the accompanying text was evidently not written.

The plates, however, seem of sufficient importance to warrant their publication, and this has been made possible through the kind interest of Prof. R. M. Strong of the University of Mississippi, formerly of the University of Chicago. Professor Strong carried out a thorough search among Professor Whitman's manuscripts for any records upon the embryology of fishes, and has most kindly written a brief introduction. To Professor Strong and to Mrs. C. O. Whitman, who most willingly aided him, sincere acknowledgements are tendered.

Samuel Henshaw.

[1] The development of flounders.<*Amer. nat.*, December, 1876, **10**, p. 705–708.—On the young stages of some osseous fishes.<*Proc. Amer. acad. arts & sci.*, October, 1877, **13**, p. 117–127, fig. 1–2, pl. 1–2.— On the young stages of bony fishes.<*Loc. cit.*, June, 1878, **14**, p. 1–25, pl. 3–10.— The development of Lepidosteus.<*Loc. cit.*, October, 1878, **14**, p. 65–76, pl. 1–5.— On the young stages of some osseous fishes. Part III.<*Loc. cit.*, July, 1882, **17**, p. 271–303, pl. 1–20.

[2] On the development of some pelagic fish eggs.<*Proc. Amer. acad. arts & sci.*, August, 1884, **20**, p. 23–75, 1 pl.— The development of osseous fishes. I. The pelagic stages of young fishes.<*Mem. M. C. Z.*, September, 1885, **14**, p. 1–56, pl. 1–19.— II. The pre-embryonic stages of development. Part first. The history of the egg from fertilization to cleavage.<*Ibid.*, June, 1889, **14**, p. 1–40, pl. 20–31.

INTRODUCTION.

By R. M. Strong.

During the autumn of 1913, with the aid of Mrs. Whitman, a search was made in the Whitman house, and some fish-embryology records were found. Among them were the descriptions of the accompanying plates. The original drawings for all of the plates except Plate XXXIII were also discovered.

Pencil marks on the original drawings assisted greatly in locating explanatory material, which was found for all of the figures in the eleven plates. It is evident that these are the plates which were mentioned in the footnote (Mem. M. C. Z., 1889, **14**, p. 7). No other manuscript was located but the material available appears clear enough. The pictures are to some extent self explanatory to the embryologist who is familiar with the first paper, and a fairly complete story is told by the records published in this paper. The plates published in the earlier paper contained figures illustrating early cleavage stages but almost no text on cleavage beyond that contained in the "explanations" of plates. Apparently the entire history of the cleavage was planned for the later paper.

The material found appeared in the form of descriptions of drawings (very likely first draft), which were fortunately grouped systematically. The records were not numbered as on the published plates but bore a number which I have placed in parenthesis after the number of the plate as it appears in this publication. The number in parenthesis occurred on the original drawings, in pencil, in almost every case. Thus the description of Fig. 1 in Plate XXXII was numbered 12 in the records left by Professor Whitman, and this number also appears on the original drawing.

It has seemed wise to do little editing, and this little has been done very conservatively. The records are consequently published largely verbatim. Significant changes or additions have been placed in brackets, especially when they have involved the use of considerable discretion. For many valuable suggestions I am indebted to Prof. E. L. Mark.

It should of course be borne in mind that these records and drawings were made a number of years ago without any of the revision that is ordinarily involved in the preparation of a paper for publication. It is not known what changes might have been made in case the authors had carried the material through to publication.

It will be noticed that the records in this publication are remarkably full and readable, as was characteristic of all of Professor Whitman's note making. He was always painstaking and careful in recording his observations, which were made with unusual attention to details. The details were also significant in his note making.

In Fig. 2, Plate XXXII, an embryonic axis is indicated by the terms "anterior," "posterior," "right," and "left." Also in the explanatory material for this plate and for others, references to this orientation occur. Professor Whitman being uncertain about the evidence for the coincidence of the first plane of cleavage with that of bilateral symmetry, suggested the problem to Miss Clapp.[1] She obtained results with toad-fish eggs which caused Professor Whitman to abandon the position, at least for some years. In conversation a few years before his death, he indicated, however, that such an orientation of the early cleavage stages should be looked for in other forms.

This publication is issued with full recognition of the fact that others, notably Kopsch[2] have more or less fully covered the same ground for other fishes. However, no such beautiful and elaborate illustrations of such material have been published, and they should be made available to students of embryology.

The original drawings and manuscript have been deposited in the Museum of Comparative Zoölogy at Cambridge, Mass., where they will be accessible to workers who may have occasion to examine them.

[1] Clapp, Cornelia M. Some points in the development of the Toad-fish (*Batrachus tau*).<*Journ. morph.*, 1891, **5**, p. 494–501, fig. 1–3.— Relation of the axis of the embryo to the first cleavage plane. <Biological lectures from the Marine biological laboratory, Woods Hole. Woods Hole, Mass., 1898. Boston, 1899, p. 139–151, fig. 1–6.

[2] Kopsch, Fr. Die entstehung des dottersackentoblasts und die furchung bei Belone acus.<Internat. monatsschr. anat. physiol., 1901, **18**, p. 43–127, fig. 1–34.— Art, ort und zeit der entstehung des dottersackentoblasts bei verschiedenen knochenfischarten.<Internat. monatsschr. anat. physiol., 1902, **20**, p. 101–124, fig. 1–15.

EXPLANATION OF THE PLATES.

PLATE XXXII.

PLATE XXXII.

Fig. 1. (12) Ctenolabrus [*Tautogolabrus adspersus* (Walbaum)] [early 16-cell stage viewed] from below (within). [*bc* = blastocoele or cleavage-cavity], Osmic and Merkel. Cap of cells browned, pellicle stained lightly red. Vacuoles occur along all of the cleavage-lines except *4–4*, *4′–4′*, in which the cleavage is not completed. Along the line *2–2*, especially in the breakage lines of *1–1*, *3–3*, *3′–3′*, the vacuoles form the roof of the cleavage-cavity and are seen to be uncolored, giving the appearance as if the cavity opens above as well as below. But [this is not the case since] there is a line of division running between the vacuoles always. These vacuoles are all on the outer surface of the lines (not on the under side). Very few are seen elsewhere in the cells. The astral arrangement of protoplasm around nuclei is strong, especially in the two pairs of end-cells, which are here plainly larger than the median cells.

The outlines of the middle cells are sharp against the pellicle, of the end-cells obliterated very strongly in region of cleavage-planes (*4–4*, *4′–4′*).

In the corner-cells of the right half of figure we see that, on the upper surface, they abut against the nearest median cell of opposite side. The upper left corner-cell is nearer to the median of opposite side on the under surface than on the dorsal. This is the only case where conditions similar to those in a frog occur.

Notice that the lines of the corner-cells have a tendency to take a radial direction, in harmony with the position of their nuclei.

The cleavage-cavity now covers a little more than the four central daughter cells, the angles being prolonged in the cleavage-lines, sometimes nearly or quite to the periphery. Along line 2–2 the cavity deepens rapidly by sloping sides to the line of vacuoles which form the roof. This cleavage-cavity is found in all eggs of this stage. Only four distinct lenticular spaces seen (dotted in Fig.). Lowering the focus a little we see that the longest ends of the rectangular area dip down beneath the surface, one turning to the right, the other to the left. Just beyond the longest angles are seen two lenticular areas such as are often seen in fresh specimens; these appear to be in the surface. *The nuclei* are also near the surface (upper surface Fig.).

This preparation is from Merkel's fluid, and hence the whole cap is colored dark red, the pellicle being only faintly stained.

Numerous small vacuolar spaces are seen in the spheres, as well as in the pellicle. I do not know if due to reagents. These vacuoles are found in all preparations of the caps.

Fig. 2. (18) Ctenolabrus; 16-cell stage from below. Osm. ¼% 20 m. Merkel. Shows every nucleus in state of division, eight lenticular spaces, the outer boundary of cleavage-cavity (*bc*) and the boundary-lines with vacuoles on the upper surface of cap. The line of junction between the two central cells (*a.b*) is about twice as long on the under as the upper side.

Notice that the general trend of all the nuclei, except two at hind end, is at right angles to the first cleavage-plane. We have here a difference between fore and hind end. The outline of the cap is very sharp everywhere, but the cap is rounded at the margin, so that the pellicle does not join the sharp edge, but does so at a lower level, *i. e.* near the lower (inner) surface of cap. [*Cf.* Plate xxxv, fig. 1, 8th section, top end].

The nuclear figures of four central cells appear shortened because they do not lie horizontally. It is the inner end of these spindles that lie lower (nearer the internal side) than the outer poles.

The twelve marginal cells are stained darker than the four central cells — giving the ring seen in colored drawing.

The achromatic poles of nuclear figures are here quite distinct, they are often convex on the outer side and concave on the inner sides.

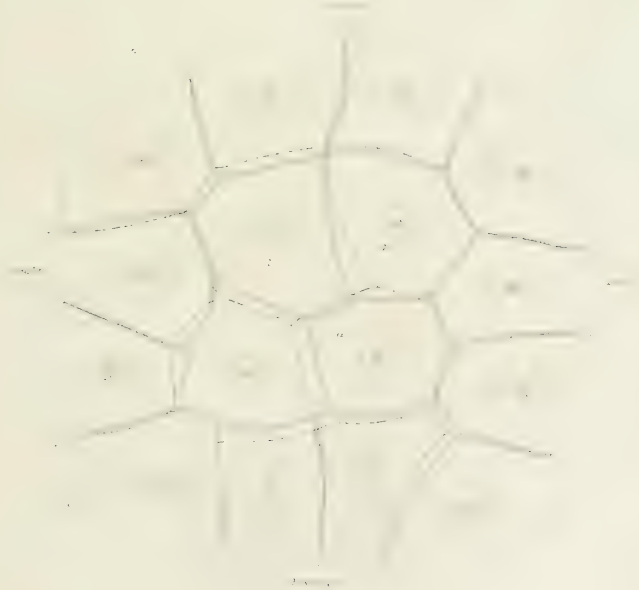


PLATE XXXIII.

Fig. 3. (19) and Fig. 4. (20) Ctenolabrus 32-cell stage in division. [Fig. 3 seen from above, Fig. 4 from below] four central floor-cells dotted, *i. e.* outlined with dotted lines [in Fig. 3]. [In Fig. 3] every nucleus is in state of division. Comparing this with Fig. 4 of the same age nearly, we see that the cap consists of seventeen marginal cells and fifteen central cells. One of the marginal cells, in cases where the cleavage is more symmetrical, as in Fig. 4, takes its place among the central cells, thus making sixteen in the margin and sixteen in center. This cell is *pc* of the right side, which is here plainly in the margin, but its inner face is much narrower than the outer, showing at least a tendency to occupy a position *above* the marginal cells, *i. e.* lapping over the marginal cells as in Fig. 4. Looking at the central cells as seen in Fig. 4, we can say that they are arranged in two double rows, crossing at right angles. The double row (= axial row) lying in axis of future embryo is two cells deep; the transverse row is two cells deep at the center, but one cell deep at the extremities.

Notice that the pair of *pre-central cells* (*pc*) lap over the marginal cells farther than the pair of *retro-central cells* (*r c*). The tendency of one of the pre-central cells to take a marginal position seems to be quite significant, for I find that the majority of caps of this age have seventeen marginal cells: four on each side, four behind, and *five* in front. In most cases the extra marginal cell in front makes the front side more convex than the hind side. This convexity is frequent in the 16-cell stage, but *more* frequent in the 32-cell stage.

In both figures it is the posterior left central (*a*) cells that abut against the diagonally opposite cells (*b*). I do not think this feature is universal.

Of the central cells, four (dotted [Fig. 3, pale letters] a–d) are completely in the floor, only one of them reaching to the upper side (dotted c) and four (*a–d*) are completely above. On the right and left, between the marginal cells and the four central ones are two *intermediate* cells (*i*), which extend from floor to roof, forming part of the upper and lower surface; this appears to be uniform in all cases that I have studied. [In Fig. 4 the lettering is reversed, *a–d* are floor-cells; pale a–d, roof-cells].

The pre-central and retro-central cells always lap, or lie completely above other cells; in Fig. 4 *r c* of the right side is completely shut out from the floor, while *r c* of the left side shows a small part of its surface (*x*) in the floor. The same is true of *pc* of the left side. The retro-central cells take part in forming the floor more often than the pre-central. In Fig. 3, the retro-central cells both show considerable surface in the floor. In perfectly symmetrical caps, we count six cells from side to side, both above and below; while from before to hind side we count five above and four or five below.

Vacuoles: — No intercellular vacuoles could be seen in [the material used for] Figs. 3 and 4, but I have other preparations of the 32-cell stage in which they show beautifully.

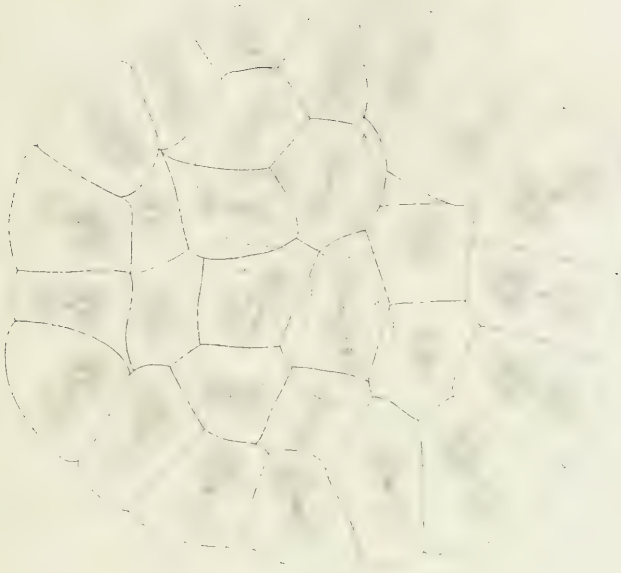
The *dimensions* are usually much wider than long. One is much wider than in Fig. 3.

Nuclei of four lateral marginal cells appear to divide indifferently, tangentially, or radially, those before and behind almost invariably radially.

Nuclei: — As to the nuclei, in Fig. 3, the nuclear figures of the marginal cells have a radial direction. In Fig. 4, they are radial before and behind, but tangential on the sides with one exception on the left side (no. 3). The nuclear figures of the *intermediate* cells are vertical or nearly so. When the nuclear figures of the marginal cells are *radial*, as in Fig. 3, the inner poles lie higher than the outer poles, hence I have shaded the inner poles more heavily. Even when tangential I think one pole may often be higher, perhaps generally so, than the other, so that in any case the division of the marginal cells results in making a ring of cells lying above and overlapping more or less the extreme marginal cells.

Cleavage-cavity: — The limits of the cleavage-cavity (*bc*) are shown feebly in Fig. 4. It is not easily traced in succeeding stages and perhaps may be said to vanish.

Thus a comparison of Figs. 3 and 4 shows that the direction of the nuclear figures may vary considerably and still not obliterate the general plan.



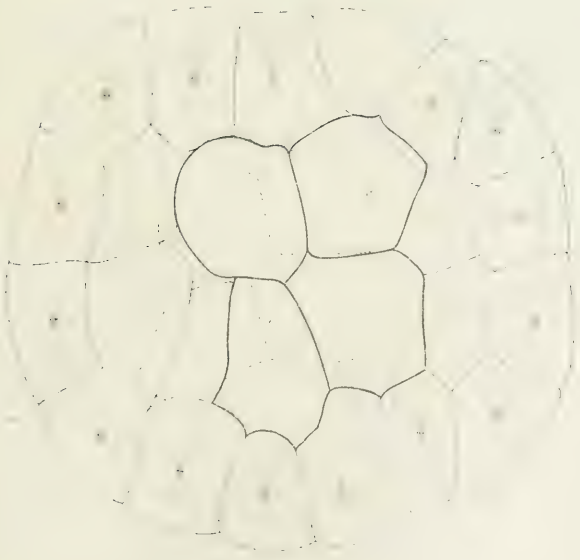


PLATE XXXIV.

PLATE XXXIV.

Figs. 5–6. (21–22) Ctenolabrus 64-cell stage. Fig. 5 from above, Fig. 6 from below. Both are in about the same state of division. In [the preparation used for] Fig. 5 the central cells are stained browner (osmic) than the marginal cells, and their distinction was only somewhat less noticeable in [the view shown in] Fig. 6. For this reason and for convenience of analysis, I have given heavy outlines to the central cells, and dotted outlines to the cells seen through the exposed surface.

I see no reason to doubt that the lettering in Fig. 6 is precisely as it should be in relation to the lettering of Fig. 4 of the previous stage. In Fig. 5 there is no obscurity except with regard to which ones of the marginal cells represent *pc* and *rc*. However as *pc* of the left side is certainly identified, it seems probable that [the numeral] *5* [between *2* and *3* of the anterior marginal cells], represents *pc* of the right side. If these two are correctly identified then there can be but little doubt in regard to *rc–rc*.

In both figures, assuming the division completed, we have thirty-six cells in the margin and twenty-eight in the center. Of the thirty-six cells, eighteen lie above (obliquely) the other eighteen, the eighteen of the upper surface, lying for the most part nearer the center, while the eighteen of the lower layer stretch away farthest from the center, extending out so as to present one half or more of the upper surface to view. Although Fig. 6 exhibits considerable variations from the radial direction of the nuclear figures which prevails in Fig. 5, still the direction is such that in the majority of cases the inner pole of the figure lies nearest the upper surface, so that the division is not horizontal, but *oblique*. The pole nearest the observer is more strongly shaded in both cases.

It is very interesting to note that the outer poles in many cases lie extremely near the margin, and, particularly in Fig. 6, one can see that the marginal daughter nuclei lie *very* near the under surface — yolk surface — of the cap. Also it is interesting to note that the marginal cells often pass into the pellicle with diffuse or blended outline.

May not the marginal cells already be considered as endoderm and the upper marginal as mesoderm? It is quite certain that all the central cells represent ectoderm.

It is important to note that in all these stages, the two intermediate cells (*i–i*) maintain uniform relations and always divide horizontally in passing to 64-cell stage. This confirms the view that the embryonic axis coincides with first plane of cleavage.

Again a portion of *rc* (*5* in Fig. 6) lies in the floor while the marginal portion lies mainly above the cells *3* and *4*. The left cell *rc* also divides obliquely, one half showing in the floor. In Fig. 5 right *rc* lies wholly in roof, left *rc* lies wholly in margin.

In Fig. 5 left *pc* touches the floor at its right end, while right *pc* lies in margin. In Fig. 6 right *pc* lies mainly above *2* and *3* and left *pc* divides obliquely, one half showing in the floor.

The nuclei when seen frontally, look like a line of large elongated granules. Viewed from the pole they generally present the form of a *ring* of granules. The achromatic poles are sometimes very plain. Some nuclear rays reach beyond the outline of marginal cells, into the pellicle. [Fig. 6, no. 1 in anterior row of cells].

Vacuoles are seen only in the outlines of the roof-cells — nowhere in the floor-cells; they are very neat in both preparations but have been omitted from the figures.

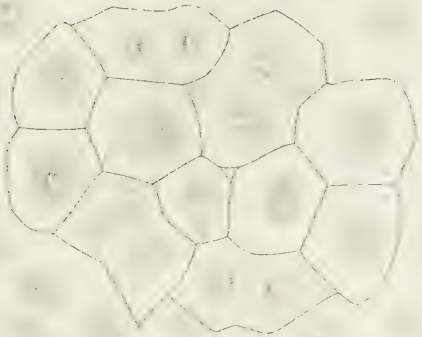
The cleavage-cavity cannot be traced with certainty; possibly it no longer exists.

In a 64-cell stage of same set, but 30 min. later, I find two of the marginal cells, at the fore or hind end of the future axis that have taken on the form and appearance of true endoderm cells.

Most of the preparations on the slide used for Figs. 5 and 6 are in the 32-cell stage. One of these 32-cell stages had a remarkable symmetry.

There were sixteen cells in the periphery and sixteen in the center. The retro-central and pre-central cells did not lap but stood abreast, like the pairs of intermediate cells, reaching from top to bottom of cap. Thus the cap was two cells deep only in the four central cells.

Endoderm: — Although I believe the 64-cell stage practically settles the endoderm and that some of the cells in this stage very often assume the endodermal condition, I think that they resume their outlines and keep the marginal position in the cap for some time later. Two hours later than Figs. 5 and 6, I find the endodermal wreath more or less conspicuous in all, but in some the wreath has not yet included more than a part of the marginal cells.



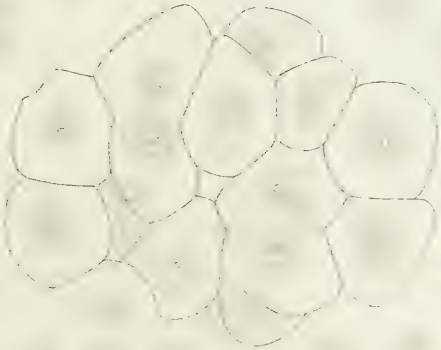


PLATE XXXV.

PLATE XXXV.

Fig. 1. (71) Ctenolabrus. [16–32-cell stage. Somewhat older than stages shown in Plate XXXII, Fig. 2]. 9 drawings of a single cap (successive) × 280. [*bc* = blastocoele; *pb* = periblast]. Corresponds to two hours 35 minutes after fecundation.

The second section has not reached nuclei but has the clear areas.

Periblast: — The *periblast* (subgerminal plate) is seen between the cells in the angles formed by the adjacent cells. It is quite thick (about .004 mm.). It looks like a thick dense membrane, is very sharp in outline, and stops abruptly in the angles of the cells. It is thus continuous with the lower surface of the cells. There is a strong contrast between it and the protoplasm. The latter is granular but the periblast is more homogeneous and membrane like. It is quite as strongly stained with carmine as the protoplasm. Very small open triangular spaces are seen above the periblastic parts.

The third section shows larger spaces in angles of cells and reveals more extensive position of periblast. One pole of three nuclei is seen. The periblast is a little less thick.

The fourth section shows the other poles of two [of these three] cells. The periblast terminates in the angles of two peripheral cells, and is entirely free from the central ones, except perhaps the right central, under which no distinct membrane can be seen but a light colored substance extends beneath this cell connecting the periblast. The periblast would seem to form by growth from the superficial yolk. This explains why it is often wanting near the center of floor, and often appears continuous with a superficial lighter colored layer of the yolk, as seen in section eight.

The eighth section cuts two marginal and two central cells. (*The four central cells are blacker than the marginal ones* as was seen both before and after sectioning). *Here the plane of division is marked. In the central cells observe the inclination.* Notice the nuclei; they are in edge of light areas, and a poorly defined small area, about size of nucleus or a little larger, is seen in each case on the outer pole of the nucleus.

The periblast is much thinner, becomes less dense, lighter, and poorly defined under central cells. Yolk [is indicated] below these cells to show that the forming periblast merges into it.

The ninth section = same cells.

The tenth section = right cell, at middle, in passing to next cell.

The twelfth section corresponds to section eight.

The nineteenth section corresponds to section four.

The periblast forms a continuous sheet in sections seventeen, eighteen, and nineteen, but is interrupted in the twentieth. It is very thin centrally in section seventeen, plainer in eighteen, plainest in nineteen.

Fig. 2. (83) 32-cell [stage section; *bc* = blastocoele]. The central cells are browned more than the marginal, the marginal are redder than the central.

The interesting fact is that the lower central cells are also more brown, just like the upper central cells, thus appearing to have the same value.

Fig. 3. (84) Transverse section, near middle [*pb* = periblast]. On the right [lower end of figure] is seen a nucleus in the periblastic swelling or *rim*. Perenyi swells the material a little and renders it easier to trace the periblast. The periblast stretches across in a very thin evanescent layer. Along the middle, it is not seen, except between two cells, where it appears to be continuous with them. Cap two layers deep in central part, but these central cells are all browner than the marginal in eggs treated with osmic and Merkel.

PLATE XXXVI.

Fig. 1. (4) Ctenolabrus. *One hour after 32-cell stage.* [*pb* = periblast]. Out of a large number of caps (20) of this stage, this one alone shows decided evidence of the first beginning of the endoderm. The cap is two to three and four cells deep in the central portion, becoming two and then one cell thick at the edge.

The upper layer of cells is not dotted, and the nuclei are colored, for sake of distinction, more deeply than those of underlying cells. There are considerable intercellular spaces as seen in undotted portions, which are probably due to the cells having been slightly disturbed, or to action of reagents. Numerous vacuole-like spaces (round) varying from size of nucleus to much smaller, are seen prevailingly in the ectoderm.

Histological evidence of a differentiation of endoderm from edge of cap: —

1. The edge-cells are stained with carmine — not browned and the nuclei are all stained with carmine, with only faint traces of browning; while the remaining cells are more or less deeply browned and the nuclei also more browned, and less brilliant than those of endoderm.

2. The radial arrangement of protoplasm is much more accentuated in the endoderm-cells than in the ectoderm, and the cells are rather more coarsely granular. We have here the best kind of evidence that the endoderm arises *late*, from the edge of the cap — thus from what may be regarded as the vegetative portion of cap. The endoderm is in process of differentiation, only certain cells having advanced so far as to be entirely outside the cap and with the characteristic absence of distinct cell-boundaries.

Four cells (*en 1, 2, 3, 4*) have advanced to the syncytial stage — representing four free nuclei in the thickened rim of the pellicle (*pb*), around which the radial lines are very clear and strong. Most of the nuclei appear to be in a condition that precedes the formation of [mitotic] figures. These four cells are wholly within the pellicle, and hence beneath the level of the outer ectoderm-cells.

The cells marked *en* are cells destined to become like *en 1–4*, but have not lost completely, except in limited portions, their definite boundaries. Many of them are not sharply defined *against each other*, or *against* the *pellicle*, with which they are continuous.

ec en 1 is a cell still in the outer rim of ectoderm, but it loses the sharp outline and blends with the pellicle and with the endoderm-cell at its right.

ec en 2 is another similar cell, which still preserves its outline, but which lies in same level as *en 1*.

ec en 3 still holds its position in the ring of cells *en*, but it is not more than very faintly and imperfectly delimited from the pellicle.

We have here, then, the outer ring of cells of cap in process of becoming fused with the pellicle, only four cells of which have become undoubted syncytial cells.

Fig. 2. (16) About one hour after 32-cell stage, from above, treated in same manner and on same slide. Here the cells are about half the size of those in Fig. 3, indicating that a single division has occurred.

Here are seen the same coarsely granular marginal cells in floor of cap, but we see that they have divided tangentially, so that we have here two cells where we before had only one. The outer row of cells is more coarsely granular than the inner row, and their nuclei are at a little distance from the dark margin of the cap proper.

Now I am inclined to take this outer row of cells as representing the first formed endoderm-cells; still it is possible that the inner row is also endodermic. If the outer row alone is endoderm, then in Fig. 3, we should have to say that the endoderm has not yet separated from cap, but simply appears as a more coarsely granular part of the marginal cells. In this case Fig. 2 would correspond in age to Fig. 1, which has also about twenty cells in the marginal endoderm.

Fig. 3. (15) Ctenolabrus. Portion of cap about 30 minutes after 32-cell stage. From below. Stained with osmic only. [*ec* = ectoderm; *en* = endoderm; *pb* = periblast].

There are about twenty cells in the periphery of the cap, forming the marginal cells of its floor and projecting a little beyond the smoothly outlined superficial cells. These cells are everywhere sharply defined except against the pellicle. Their boundary line against the pellicle is tolerably distinct but not smooth. It is more or less ragged as if the delimitation was not complete.

An important feature of these cells, in contrast with the finely granular cells elsewhere, is their coarsely granular nature. They are more and more coarsely granular as we pass from the inner to the outer margin. The outer half of these cells is thinnest and more coarsely granular than the inner half.

Notice also that the nuclei of these cells are in the first stages of division; *i. e.* they are elongated radially and are faintly striated with a darker dotted line in the middle zone. The achromatic spindle and stellate rays are not to be made out, the preparation not being favorable to making out fine details of nuclear structure.

These cells fit into the other floor-cells which are shrunken away from them at this point.

Fig. 4. (87) One hour 30 minutes after 32-cell [stage]. [*pb* = periblast]. Section near middle. Here the marginal cells are very distinct, but owing to method of treatment the subgerminal plate is very indistinct. Cap two cells deep at margin (sometimes two sometimes only one), three cells deep in middle. All the central cells from top to bottom are blackened alike.

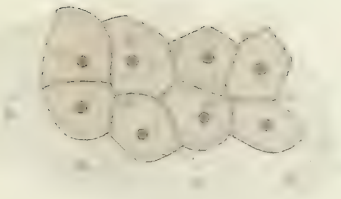
Fig. 5. (85) Transverse section near middle of 64-cell [stage], (30 minutes after 32-cell) Os and CrO_3 3 days.

The marginal cells are lighter and redder than the central, the latter being slightly more tinged with osmic. The cells are closely packed and the subgerminal plate everywhere in contact with cells except at one point where it is broken. This is probably due to the contraction caused by the chromic acid.

Fig. 6. (86) One hour after 32-cell = fig. 1 in age). Transverse [section] near middle. (Os and Mk. 3 days). [*bc* = blastocoele; *pb* = periblast].

The periblast is continuous under cap in most places. The marginal cells are distinct in color.

In all caps of this age, I find the central cells smaller than marginal and from two to three cells deep; the marginal are from one to two deep.



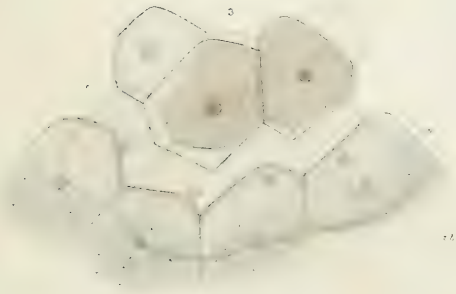


PLATE XXXVII.

PLATE XXXVII.

Fig. 1. (8) Ctenolabrus from inner surface. Os $\frac{1}{3}$% 15 minutes, Merk. 3 days. 2 hours after 32-cell stage.

In the wreath are about twenty-seven cells. Protoplasm radiate around some, no nuclei in division. Cap = two to four cells deep; smaller in central, larger in periphery. Round cells are seen in the central portion.

en 1, 2, 3 = delimited.

en 4 not delimited against pellicle.

en = syncytial endoderm-cells.

Endoderm colored red, cap brown.

For distinction, nuclei of *en* are red, nuclei of cap brown (Indian red).

Most of *en* lie under, not outside, the margin of the cap. In a number of cases the nuclei are half under cap, half exposed. [*pb* = periblast].

Fig. 2. (88) Two hours after 32-cell [stage]. 42 sections .005 mm. thick. [*pb* = periblast].

The first section cuts edge of cap. Dividing line between marginal cells does not cut quite through the periblast.

The twenty-first section through middle. Marginal cells small, but well colored red, while the central cells are all brown.

The twenty-fourth section shows an inner cell that is reddish, but less so than the marginal cell.

The twenty-seventh section shows no marginal cell.

The thirtieth section shows red cell above the marginal cell.

These facts are to be explained by supposing that the marginal cells are constantly dividing and adding cells to the cap, which soon after division become like the other cells of the cap, taking brown color from osmic acid.

At this stage the subgerminal plate is pretty complete everywhere.

It is the upper portions of the marginal cells that are constantly cut off and added to the cap, until at length the basal portion ceases to have any connection, and its nuclei spread in all directions.

Fig. 3. (9) Ctenolabrus. Two hours after 32-cell stage. [*pb* = periblast]. A portion of cap from above. The endodermal wreath is here very distinct and contrasts with the ectoderm everywhere in the staining. There are ten pairs of cells and an older one, en^1. Three of the pairs [en^1, en^2, en^{10}] are tangential and the rest are oblique or radially placed. In *en 1* the division is so nearly completed that only the most faint traces of interzonal filaments are discernible. The right hand cell of the pair is in plane above the left, and [is] more sharply defined but colored the same.

en 2 shows last end of division with filaments still visible. A light line between cells indicates plane of division which is not completed. Both cells continuous with pellicle (*pb*).

en 3, [The number does not appear on the plates, but the cells are evidently those between *en 2* and *en 4*]. Division completed, inner cell highest, and best defined, but colored lighter than rest of ectoderm.

en 4, inner cell also highest but below the highest of pair *en 3*. Division completed and outline clear in both.

en 5, same as in 4.

en 6, both in same plane — faint traces of spindle.

en 7, division completed.

en 8, faint spindle-cells not sharply outlined except against the floor-cells of cap.

en 9, outlined inner cell lighter than ectoderm and appears to be paired with the outer longer cell.

en 10, division not completed, pretty well defined but flowing into pellicle.

All the inner cells of the pairs, except in *en 3*, lie in the floor of the cap, and in most cases abut against surrounding cells. The paired nature of these cells is most evident. Most of the inner cells are covered by ectoderm but wherever they are uncovered, they are colored like endoderm.

PLATE XXXVIII.

PLATE XXXVIII.

Fig. 1. (2) Cap of Ctenolabrus. [*pb* = periblast]. Osmic 15m. ($\frac{1}{8}$%), Merkel 3ds. Same age as [in Fig.] 2, but not *quite* so far advanced, *i. e.* the nuclei of [marginal] row are somewhat elongated, and in a few cases faint asters are seen at the poles of the nuclei, but no striation is visible in the nucleus.

The entoblastic wreath is characteristically granular and thins out rather abruptly into the pellicle, just beyond the nuclei. The cells on both surfaces of cap were distinct. The cell-boundaries around these [wreath] nuclei were visible here and there, but very faint as shown in figure. Now and then a nucleus of a second inner row — just under edge of blastoderm — is seen. Here also the nuclei are mostly elongated in a radial direction.

Color: — Wreath and pellicle colored slightly with carmine, but the cap browned with osmic. The contrast between *granular pink* wreath and light brown cap is striking here as in all cases thus treated.

Fig. 2. (1) Cap of Ctenolabrus. [*pb* = periblast]. Seen from outer surface three hours after the 32-cell stage is reached. To the cap adheres the entoblastic wreath, which is thickest at the edge of cap, gradually thinning out towards the periphery, which is ragged in consequence of being broken from the pellicle. This wreath is stained faintly with carmine (borax alcohol) while the cap is browned by osmic acid and not stained by carmine. The wreath reaches under the cap for a short distance but not to the central parts of cap. There is a single row of nuclei, radially placed (some tangential and oblique), and *all* in process of division, mostly showing a well-marked nuclear plate in different stages of division, and asters (rather faint). The cell outlines about the nuclei are not visible, except in a few instances. Most of the nuclei of the ectoderm are round; one is seen in division, and beneath it is a nucleus of the endoderm-wreath in division. Although there is, broadly speaking, only one row of nuclei visible, an inner row makes itself apparent in several places and now and then a nucleus (dividing) may be seen just under the edge of the cap.

PLATE XXXIX.

PLATE XXXIX.

Fig. 1. (3) Ctenolabrus, under (inner) surface. Treated as Figs. 1 and 2, [Plate XXXVIII], four hours after 32-cell stage. One hour after Figs. 1 and 2 [Plate XXXVIII]. In this cap the nuclei of the endoderm are strongly colored and very well defined. One can see by the nuclei that the endoderm extends for only a short distance under the cap. The majority of the nuclei are outside the cap.

Fig. 2. (89) [Seven sections]. Three hours after 32-cell stage. [*bc* = blastocoele; *pb* = periblast]. (Os, Mk. 3ds).

Second section shows only one or two outlined cells, the outlines being indistinctly marked.

The third section shows two well-outlined cells; the right is sharply marked inferiorly. There is a partial outline of a dark cell of the cap.

The fourth section shows the first appearance of the sub-germinal plate. All the red cells are shaded by dotting.

The sixth section shows the subgerminal plate thinner.

The sixteenth section shows on the left a red cell that looks as if it was to enter into cap.

The twenty-sixth section is near middle. Here sometimes no nucleus is seen in periblast, at other times one or even two. Subgerminal plate very thin, wavy in outlines as in section sixteen.

The twenty-eighth section shows an inner cell in process of splitting off, possibly destined to become one of the cap cells.

The thirty-third section showed a similar case.

I think it is possible that cells are still added to the cap, but that this process is nearly concluded, so that the periblast as a cell layer may be now considered established.

Fig. 3. (90) [Later stage. *bc* = blastocoele; *ep* = epidermis; *pb* = periblast]. Section near middle. The periblast is very thin, vanishing or nearly so near the center of field. Epidermis well marked off.

On left is a single periblast cell that looks as if it was a cap-cell. The fact that the periblast becomes so very thin indicates that cells are added to the cap up to about the time the ring begins to form.

The nuclei of the periblast are still confined to the thickening beneath the margin of cap; on the left [*i. e.* lower end of figure] a single nucleus is somewhat advanced from the margin towards the center, but this is exceptional in these sections.

PLATE XL.

PLATE XL.

Fig. 1. (92) *P.[aralichthys] oblongus.* [*bc* = blastocoele; *ep* = epidermis; *pb* = periblast]. 61 sections. This figure is the twenty-fifth [of sixty-five sections] and is like the middle ones. The periblast is thin but extends farther under the cap than in Fig. 2. Near the center the layer fades out and is not recognizable, but four nuclei are very distinct, showing that the layer exists though thin and perhaps not fully differentiated. The nuclei extend under the entire cap although the ring has scarcely begun.

This shows that the periblast has already begun to expand as an independent layer and has therefore probably ceased to contribute directly to the cap.

Fig. 2. (91) *P. oblongus.* [*bc* = blastocoele; *ep* = epidermis; *pb* = periblast]. Three hours after 32-cell stage. Four of sixty nearly longitudinal sections. Left end = embryonic region.

The second section does not reach cap; third touches cap.

The fourth section shows some of cap, and periblast thinner at middle.

The eleventh section shows periblast still thinner in middle. Nuclei are more numerous at left end all through these sections. I think the periblastic nuclei are more numerous under region of embryo than elsewhere.

On the seventeenth section the periblast is scarcely visible at center beneath cap. On the sixteenth two nuclei were found near the middle of the subgerminal plate, although the plate is scarcely traceable.

One nucleus was seen near middle of the nineteenth section and one in twenty-fourth. The periblast is somewhat less in bulk on the middle sections than on the thirty-eighth which I have drawn. Periblast is here about same in quantity as in Fig. 2, Plate XXXIX. (Three hours after 32-cell).

PLATE XLI.

PLATE XLI.

Fig. 1. (96) (*P. oblongus*) from above. Very early stage of ring. [*pb* = periblast]. The ring has just become well defined everywhere and the embryonic fold is seen somewhat bulging centripetally. The ring is nearly even in width everywhere, except for being a little wider as it enters the embryonic region.

Width of ring = .02 mm.; in embryonic region = .04 mm.

Cap almost perfectly circular. Diam. of cap = .55 mm.

The *thick wall* (wreath) of periblast is not yet fully covered so that about one row of nuclei is seen all around. The number of nuclei could not be accurately determined, so they were put in at random guided by what was known of other cases. The outlines of only superficial cells (epiblast) are seen, but nuclei of deeper cells are given. The epiblast is seen in profile along the margin. The posterior half of the cap is thicker than the anterior, and this is shown by heavier dots and lines. The cap should appear convex — but the lithographer could [not] be instructed to shade it properly.

The posterior [lower half of figure] half is the embryonic area, the anterior [upper] the pre-embryonic area.

The ring is now only .02 mm. [in width], later it becomes .12–.15 mm. in width.

Fig. 2. (97) [Section of] cap before appearance of ring, cleavage cavity shallow.

Fig. 3. (98) [Section] just before ring. [*bc* = blastocoele; *pb* = periblast]. Embryonic area thicker than pre-embryonic area. (Large yolk cells supplied).

Fig. 4 (99) [Section. *bc* = blastocoele; *pb* = periblast]. Blastoderm thinned out much in anterior half, where for some distance the lower layer is only one cell deep. Towards the anterior edge the under layer thickens.

PLATE XLII.

Fig. 1. (94) *P. oblongus.* Sections drawn at intervals. Young ring stage cut transversely into sixty-three sections (.0075 mm.). [*bc* = blastocoele; *ep* = epidermis; *pb* = periblast].

Diagram 12 = longitudinal median section, constructed from the transverse sections. .0075 mm. × 280 equals apparent thickness of each section. This amounts to 2.1 mm. 2.1 × 63 gives apparent length of the cap, which is 132.3 mm. Measuring off 132.3 mm., I divided it into sixty-three equal parts, and then by vertical measurements of each section constructed the diagram. Thickness of upper layer in the sections. (Apparent of magnified 280).

8th section	= 15 mm.	27th section	= 11.5 mm.
10 " "	= 16 "	28 " "	= 11 "
12 " "	= 15 "	29 " "	= 10 "
13 " "	= 15 "	30 " "	= 10 "
14 " "	= 14 "	31st "	= 10 "
15 " "	= 15 "	32d "	= 10 "
16 " "	= 13 "	33rd "	= 10 "
17 " "	= 14 "	34th "	= 9 "
18 " "	= 13 "	35 " "	= 8 "
19 " "	= 14 "	36–50th "	= 8 "
20 " "	= 14 "	53d "	= 10 "
21st "	= 13 "	54th "	= 9.5 "
22 d "	= 13 "	55 " "	= 9 "
23rd "	= 13 "	56 " "	= 10 "
24th "	= 12 "	59 " "	= 10 "
25 " "	= 12 "	60 " "	= 8 "
26 " "	= 13 "	61st "	= 8 "

The second section takes in many epiblast cells, which are seen partly in surface owing to the convexity of the cap near margin.

Nearly all the cells are in some stage of division throughout all the sections.

Notice that the nuclei of the periblast are few in section two, more in three, most in five and are fewer towards the middle of cap (37th). They are more numerous beneath the embryonic fold than elsewhere under the ring.

The *lower layer* becomes distinct only in section five, where we see not only a line of division, but notice that the nuclei retreat from this line somewhat.

The lower layer is thickest (3–4 cells deep) in the embryonic fold; elsewhere the ring where it is well begun is 1–2 cells deep. The ring is seen as a true *infolding* in the thirty-second section and especially in the thirty-fifth. In some points the ring is scarcely begun, *i. e.* there is no distinct ring. The axial portion of the ring ceases with the tenth section, being thus less than $\frac{1}{6}$ of the entire length of the cap.

The *upper layer* is thickest over the embryonic apical fold, being here from 4–6-cells deep. This thick area thins off gradually beyond the twenty-fifth section (*i. e.* between twenty-fifth and thirty-fifth). From the thirty-fifth onward the diminution in thickening continues but in a much less marked degree, dwindling down to about half the thickness of the embryonic fold.

The thickness of the upper layer is nearly uniform in all transverse sections from margin to margin.

The upper layer is composed of an epidermis and a deeper neural layer (neural at least in its apical region). The epiblast is composed of flattened cells that abut against the highest angle of the periblast. In no case does the ring appear to arise by an infolding of this layer; on the contrary, there is sometimes a small space left between the marginal epiblast cell and the nearest cell of the ring (so in 27th). The deeper neural layer, however, bends into the infolding lower layer as shown in the twenty-seventh, thirty-second, thirty-fifth, and thirty-seventh. The nuclei may be seen in all stages of division in the ring region.

The number of cells in a section of the ring varies from two (32nd) to four (27th, 37th). In the floor, the ring is one cell deep (except in apical region — see above) or sometimes two cells deep (most often at the inner edge). Later it is plainly one cell deep.

The *cleavage-cavity* begins with the tenth section and ends with the sixtieth.

The periblast is thicker under the apex than at the opposite point.

Section sixty is much thinner than section five (both are at the boundary of the cleavage-cavity or at a point where the lower layer begins to be distinct from the upper layer).

The periblast plainly does not contribute elements to the ring; it is more difficult to decide about the axial portion. In some sections, notably in the axial portion, I find cells sometimes more or less delimited in the periblast (3rd, 5th, 6th, 8th). This delimitation does not, however, show that periblast cells pass into the cap, as such are visible at *certain stages* of the nuclear transformations. I am inclined to think — not certain — that the periblast does not enter into the ring at any point.

994 4

QL
1
H35
v.40

Harvard University.
of Comparative Zool
Memoirs

Biological
& Medical
Serials

PLEASE DO NOT REMOV
CARDS OR SLIPS FROM THIS

UNIVERSITY OF TORONTO LI

STORAGE